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Actual and Optimal Adjustments on 320-Acre Farms in West-Central Ohio, 1957-1959

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in cooperation with

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Actual and Optimal Adjustments on 320-Acre Farms in West-Central Ohio, 1957-1959

J. R. TOMPKIN and F. J. RAFELD[1]

SUMMARY AND CONCLUSIONS

A cooperative study on farm adjustment in nine west central Ohio counties was conducted during the 1957-1959 period by the Economic Research Service, U. S. Department of Agriculture, and the Ohio Agricultural Research and Development Center. Information for the 1957 crop year was obtained on 63 of 110 randomly drawn 320-acre, owner-operated farms. Data for 1958-1959 were collected on a subsample of 21 farms.

The purpose of the project was to obtain an inventory of farm resources on these farms, a knowledge of how these resources were used, what adjustments the sample operators made to price and other stimuli, and to what extent profitable adjustments can and should be made on the sample farms and ultimately in the entire region.

The sample area lies in the Ohio portion of the Corn Belt. The nine counties selected represent only 11.37 percent of total farmland in Ohio but contain 13.75 percent of harvested cropland, 17.74 percent of the harvested corn acreage, 19.66 percent of the corn production, and 21.14 percent of the hogs raised in the state.

Changes in farm size and farm numbers constituted the most significant adjustments by the farmers in the sample area. Many operators ceased farming by selling or renting their farms. Substantial farm enlargement through purchase and leasing took place in the area. Census figures show that mean farm size in the sample area increased from 118.8 to 133.6 acres, or 12.5 percent, during the 1954-1959 period.

An adjustment was defined as a significant change from the operator's normal organizational or practice pattern as a result of a decision by the operator. Adjustments were classified as follows: cropping, livestock, labor, machinery, technological, cost, improvements, and capital use.

Several sample farmers made adjustments in the size of various crop or livestock enterprises but the net total change of all operators due to these adjustments was negligible because the individual increases and decreases tended to compensate. Appreciable short run shifts to price changes were made in the case of spring and fall farrowing in response to hog price fluctuations. Weak response of corn and soybean acreages to price changes also were noted. Corn acreage declined during 1958 as the acreage reserve program was available but increased in 1959 when this program was withdrawn.

Machinery inventory value per crop acre generally decreased over the study period as farmers curtailed machinery purchases after 1957. Capital equipment purchases correlated highly with current annual cash receipts. Expenditures for custom machines were inversely correlated with annual cash receipts.

Dairy farms averaged the most adjustments per farm, with hog farms making the least number of significant changes. There was considerable variance in the group of sample farmers in number of adjustments made, with the distribution approximately normal.

Correlations were run with the various types of adjustments as dependent variables and with 26 independent variates comprised of factors postulated to have some probability of relationship with the dependent variables. Statistically significant relationships were isolated for each type of adjustment.

Changes in livestock and milk prices, level of cash costs and cost efficiency, and the operator's policy of re-investment in the farm business over and above committed cash outlays were associated with many of the adjustment categories.

In the association of price changes and adjustments, the conclusion was that operators adjust to price changes but only after a 1-year lag and an indication that a trend has been established.

Because all but one of the significant correlations between adjustment types and cash cost level and cash cost per PMWU were positive, it was concluded that adjustments result in higher total cash costs of operation.

The analysis further indicated that re-investment in the farm business over annual commitment was being spent for machinery and improvements.

The group of operators influenced by non-economic factors made fewer adjustments than the remainder of the operators but the difference between the two groups was significant for only two of the

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four factors for which data were obtained. From this, it was concluded that although non-economic factors generally acted as only slight deterrents to adjustment, they did have some effect on adjustment.

The resource situation of each sample farm was linear programmed with variable beef and hog prices. Graphing these results produced a price map for each farm. The number of changes in optimum plans within a given range of product prices for a given farm serves as a good measure of the degree of enterprise flexibility on that farm.

The optimum organizations determined by linear programming were compared to the actual organizations of the farms. Generally, the recommended adjustments were to decrease acreages of oats and rotation pasture and increase hay. Recommended livestock adjustments were to reduce dairy and beef cows, hens, and ewes and to increase beef feeders. The income difference between optimum and actual farm organization averaged $6,333 per year per farm.

Many deterrents to adjustment were noted during the study. These included resource rigidity, weak capital position, voluntary resource rationing by the operator, lack of knowledge of costs and returns of alternatives, and the cost structure of the individual farm. Adjustments themselves frequently require other changes, thus increasing total adjustment costs enough to preclude any resource shifts.

INTRODUCTION

In 1956 the Farm Production Economics Division of the Economic Research Service, U. S. Department of Agriculture, and the Ohio Agricultural Research and Development Center inaugurated a cooperative research project in west-central Ohio. The study was made to provide economic information which would be helpful to Ohio farmers in making profitable adjustments in their farm organizations and to provide a research background for development and appraisal of farm programs. This report deals with the adjustment problems found on 320-acre farms in the study area.

OBJECTIVES

The specific objectives of this study were:

- To obtain an inventory of farm resources in west-central Ohio and a knowledge of how these resources are used.
- To learn to what extent farmers attempt to adjust their production to meet changes in product prices and production costs.
- To determine what conditions and what variables influence the nature and extent of profitable adjustments which individual farmers can and do make.

PROCEDURE

Project Area

A nine-county farming area in west-central Ohio (Figure 1) was selected for the study because it represented the commercial farming area of the state comprising the eastern tip of the Corn Belt region.

The topography of the sample area varies from nearly flat to sharply rolling, with gently rolling Miami brown silt loam and silty clay loam soils predominating. Rainfall averages about 38 inches a year. Hog, dairy, and general livestock farms are most numerous but some units are operated as cash grain farms. Beef, cow-calf, sheep, and poultry operations are minor supplemental enterprises on some farms. A few operators derive a major share of their gross returns from fattening feeder cattle. Crop rotations vary from corn-small grain-meadow-meadow to corn-corn-small grain-meadow, depending generally upon topography and the intensity and type of livestock production.

The relative agricultural importance of the nine-county project area is shown in Appendix C by a comparison to state totals for Ohio for land use and production statistics. It can be seen that while the area comprises only 10.23 percent of the state's 88 counties, 11.37 percent of total farm land, and 11.18 percent of the farms in the state, it contributes a higher percentage of Ohio's agricultural production.

Sampling Method

The sample consisted of 110 owner-operated[2] (or father-son partnership) farms in the 270-to 370-acre size range.[3]

A two-stage random sampling procedure was used. The primary sampling units were townships. County ASCS records were used to identify those farms which met the sample requirements in each sample township. These farms were then arrayed by number and 110 were drawn, taking from each township that number of sample farms corresponding to the proportion of the township's owner-operated 320-acre farms to the total owner-operated 320-acre farms in the sub-sample of townships. This assured all farms in the size range and with this tenure type an equal chance of being drawn.

The 110 sample farms were visited in the fall of 1956. Forty-seven farms were ineligible because of

[2]The restriction of the sample farms to owner-operator or father-son type operations was an attempt to reduce variation due to tenure. Owner-operated farms, as used in this report, include only farms on which at least 90 percent of the land is owned by the operator.

[3]The sample 270-370 acre farms will be referred to as 320-acre farms in the remainder of this bulletin.

errors or changes in tenure, farm size, refusal, tract omission, or because the operator had ceased farming. A schedule was completed for 63 farms.

Information was obtained from each of the 63 eligible operators as to resource inventories, farm organization, production practices, production inputs and outputs, costs, and indebtedness. Each operator was also asked to give his price and production expectations for the coming year.

FINDINGS

Inventory of Resources, January 1, 1957

Total amounts of land and cropland on the sample farms January 1, 1957, as reported by the operators, were compared with the census of all 320-acre farms in the area. These are shown in Table 1.

The capital resources, exclusive of land value, on the sample farms as of January 1, 1957, amounted to more than $55,000 per farm, with a range of $21,831 to $108,324 per farm. These estimates were derived from current market values or appraised values as determined by the authors. The distribution of capital assets is given by type-of-farm classification in Table 2.

The debt patterns of the selected operators are shown in Table 3. These are classified as short-term indebtedness, amount of real estate mortgage, and percentage of operator equity in capital assets.

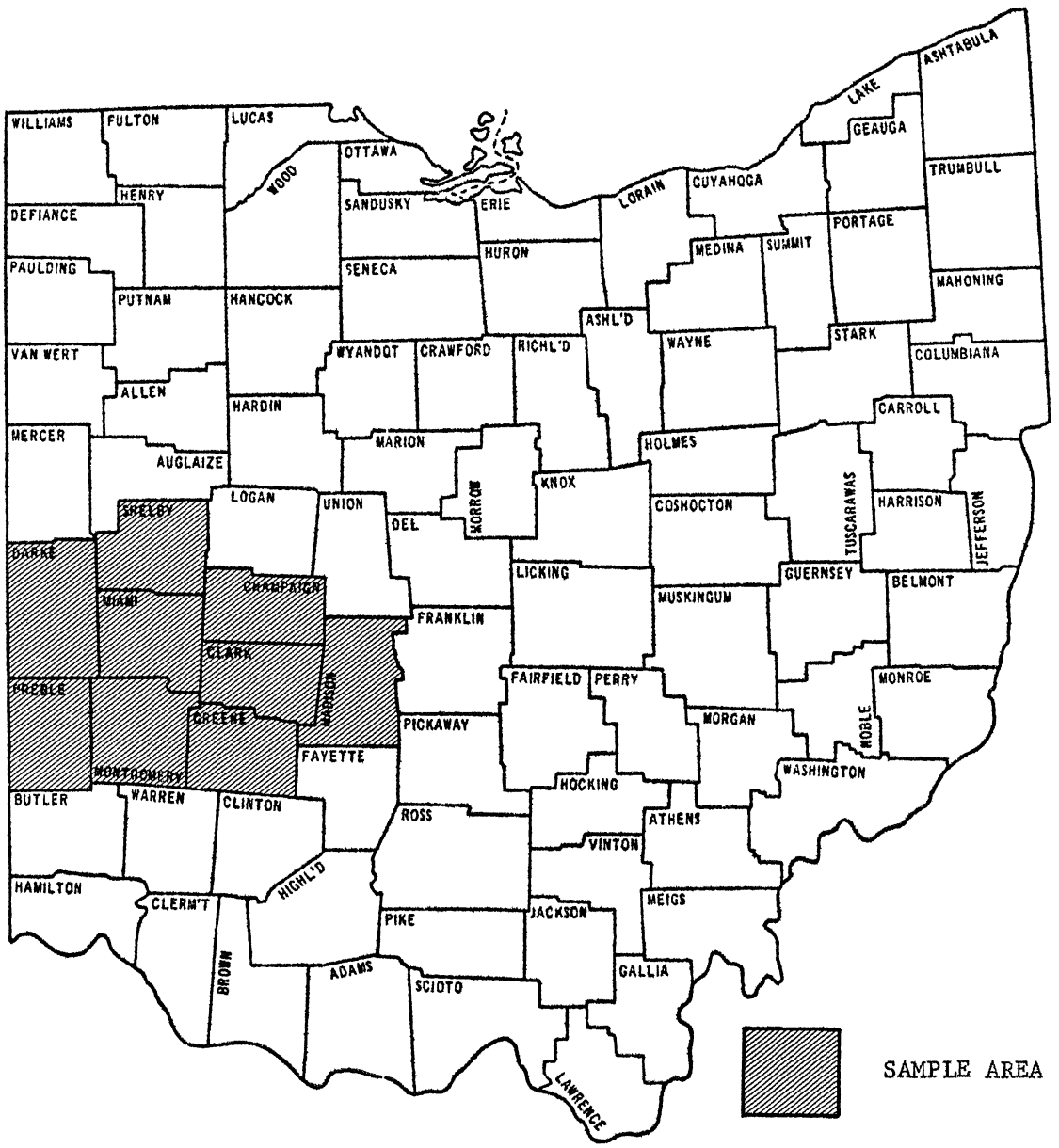

Fig. 1.—Counties included in study.

Factor Use on Sample Farms in 1957

After the initial enumeration of 63 sample farms in the late fall of 1956, a sub-sample of 35 farms was drawn. Complete records were obtained for 29 of these farms during 1957. This sub-sample of farms was tested for homogeneity with the larger sample by group comparison methods to confirm its representativeness of the larger sample. Some of these farms were dropped from the sample during the 1957-1959 period, as explained later in this report.

Resource use in 1957 on the 29 sample farms is indicated in Tables 4 and 5. The acreage in various crops, average yields, total production, and feed disposition data are shown in Table 4. Data for livestock are shown in Table 5.

Labor requirements per farm were computed, using standard rates of performance. The labor requirements were then compared with the labor available, using the length of working day reported by the operators. The highest monthly labor requirement occurred in June on 52 percent of the farms. March and October required most labor on 19 and 14 percent, respectively. March and November were the critical labor months (labor available minus labor required was least) on 67 percent of the farms, with June and October showing most labor shortage on the balance of the farms. There was no surplus operator and unpaid family labor in critical periods. In fact, operators hired an average of 1,552 hours per farm during the year. Only one operator did not hire any labor during the year.

During 1957, two operators had an off-farm job. One worked off the farm for 6 months and another for less than 50 days.

TABLE 1.—Comparison of Numbers and Acreage of Sample Farms and All 320-Acre Farms in the Nine-County Selected Area.

Item	(A) In Sample	(B) In 9 County Area*	(C) Percentage Col. (A) Is of Col. (B)
Number of all 320-acre farms	63	658	9.57
Number owner-operated 320-acre farms	63	140	45.00
Acreage of farmland in owner-operated 320-acre farms	19,307	48,440	39.86
Acreage of cropland in owner-operated 320-acre farms	15,188	37,842	40.14
Average acreage of farmland per owner-operated 320-acre farm	306.5	346.0	——
Average acreage of cropland per owner-operated 320-acre farm	241.1	270.3	——

*Taken from or derived from U. S. Census of Agriculture for Ohio, 1954 and 1959.

TABLE 2.—Inventory of Capital Resources, Excluding Land, on 320-Acre Farms, Jan. 1, 1957, by Type of Farm*

Type of Farm	Number of Farms	Total Capital Resources: Average per Farm	Value of Buildings and Improvements: Average per Farm	Value of Buildings and Improvements: Percentage of Capital Resources	Value of Machinery and Equipment: Average per Farm	Value of Machinery and Equipment: Percentage of Capital Resources	Value of Livestock: Average per Farm	Value of Livestock: Percentage of Capital Resources	Value of Feed: Average per Farm	Value of Feed: Percentage of Capital Resources
	Number	Dollars	Dollars	Percent	Dollars	Percent	Dollars	Percent	Dollars	Percent
Dairy	8	$60,318†	$28,641	47.5	$11,162	18.5	$14,358	23.8	$6,156	10.2
Beef	9	66,014‡	30,962	46.9	12,597	19.1	13,224	20.0	9,232	14.0
Hog	14	54,848**	25,132	45.8	10,746	19.6	10,802	19.7	8,168	14.9
Cash grain	9	43,563††	22,087	50.7	8,571	19.7	4,366	10.0	8,539	19.6
General purpose	23	53,757‡‡	27,199	50.6	10,049	18.7	10,165	18.9	6,345	11.8
Total	63	$55,127***	$26,730	48.5	$10,498	19.0	$10,448	19.0	$7,452	13.5

*Type of farm was determined by percentage of total gross receipts contributed by various enterprises. For example, if more than 50 percent of gross receipts came from the dairy enterprise, the farm type was dairy. If more than 50 percent from hogs or from cash grain, the farm was a hog farm or a cash grain farm, respectively. Where no enterprise contributed as much as 50 percent of gross receipts, the farm was classified as a general livestock farm.

†Range $32,820 to $81,055; standard error $17,450; 5 farms within mean ± one standard error.

‡Range $36,675 to $108,324; standard error $24,604; 5 farms within mean ± one standard error.

**Range $38,789 to $99,036; standard error $16,729; 12 farms within mean ± one standard error.

††Range $21,831 to $60,716; standard error $12,540; 6 farms within mean ± one standard error.

‡‡Range $25,824 to $81,812; standard error $16,685; 16 farms within mean ± one standard error.

***Range $21,831 to $108,324; standard error $18,195; 43 farms within mean ± one standard error.

TABLE 3.—Summary of Indebtedness by Farm Type on 63 Sample Farms, Jan. 1, 1957.

Type of Farm	Number of Farms	Real Estate Mortgages		Non-Real Estate Indebtedness		Average Equity of All Farms*
		Number of Farms	Average Size of Mortgage	Number of Farms	Average Size of Loans	
	Number	Number	Dollars	Number	Dollars	Percent
Dairy	8	5	20,040	5	7,660	84.16
Beef	9	2	20,000	4	14,250	91.54
Hog	14	4	8,000	5	1,960	97.43
Cash grain	9	4	22,500	2	6,750	89.03
General purpose	23	5	18,400	9	4,672	94.72
Total	63	20	17,710	25	6,426	92.78

*The value of land is included in determining equity.

TABLE 4.—Resource Use in Major Crop Production, Average per Farm on 29 Sample Farms, 1957, by Type of Farm.

Item	Unit	5 Dairy Farms	4 Beef Farms	6 Hog Farms	6 Cash Grain Farms	8 General Purpose Farms	29 Total Farms
Farmland	Acre	322.6	318.5	295.7	290.2	320.6	309.2
Cropland	Acre	259.4	241.2	255.2	222.8	226.0	239.2
Corn							
Acres	Acre	58.6	84.2	104.7	70.5	51.1	72.1
Production	Bushel	3691.2	6509.0	7961.7	3930.7	3648.5	5001.2
Yield	Bushel	63	77	76	56	71	69
Fed	Bushel	3537.6	5237.2	10200.5	1948.8	3252.5	4743.2
Sold	Bushel	360	2328.0	352.2	2994.5	445.4	1198.4
Wheat							
Acres	Acre	26.6	19.5	28.7	24.7	21.8	24.3
Production	Bushel	723.2	492.5	955.2	681.2	523.8	675.7
Yield	Bushel	27	25	33	28	24	28
Fed	Bushel	27.4	56.2	11.5	12.0	117.0	49.6
Sold	Bushel	801.0	263.0	833.5	439.2	620.6	608.9
Soybeans							
Acres	Acre	16.2	9.5	17.3	26.5	23.9	19.8
Production	Bushel	385.8	241.5	490.7	730.8	562.4	509.4
Yield	Bushel	24	25	28	28	24	26
Sold	Bushel	194.2	513.5	378.0	287.3	407.0	354.2
Oats							
Acres	Acre	28.6	20.5	14.8	16.8	23.6	20.8
Production	Bushel	936.8	837.2	710.8	673.3	1059	855.5
Yield	Bushel	33	41	48	40	45	41
Fed	Bushel	709.4	654.8	1041.3	190.2	1231.1	807.0
Sold	Bushel	320.0	150.0	0	733.5	104	256.3
Hay							
Acres	Acre	56.4	36.2	41.3	23.5	43.8	40.2
Production	Ton	123.8	55.8	100.3	40.3	88.4	825.2
Yield	Ton	2.2	1.5	2.4	1.7	2.0	2.1
Fed	Ton	133.4	79.5	110	48.8	93.2	925.5
Sold	Ton	2.8	7.0	9.2	2.5	0	3.9
Acres rotation meadow	Acre	33.2	31.0	40.5	33.2	31.2	33.9
Acres permanent pasture	Acre	45.6	38.8	23.5	39.5	46.6	39.1

FARM SIZE ADJUSTMENTS[4]

Changes in farm size constituted an important type of adjustment by the sample farmers during the 1957-1959 period. Only 63 records were obtained for 1956 from the 110 farms drawn for the sample. Of the other 47 farms, 32 were ineligible for inclusion in the sample because reported tenure status was not correct, five operators preferred not to cooperate, four operators quit farming, and six farms had changed size between 1956 and 1957 so that they were no longer within the 270-370 acre size range.

[4]For the purposes of this study, the term "adjustment" is defined as a significant departure from the operator's 1957-1960 normal pattern of organization or operation, made as a result of a decision by the operator. When no normal pattern of organization or operation was discernible, a change was not considered an adjustment unless it was of such magnitude that the intent of the operator was clearly evident. Thus the number of adjustments isolated in the analysis should be considered as a minimum measure.

. Farm enlargement and going-out-of-farming continued to be major forms of adjustment in the sub-sample of 35 farms selected for continued enumeration. During 1957, two operators rented part of their farms, two others refused to cooperate, one enrolled in the soil bank, and one farmer enlarged his farm. This left 29 operators for whom complete data for 1957 were available.

During 1958-1959, four operators enlarged their farm acreage, three others quit farming, and one refused to continue cooperating. This left 21 farms in the 270-370 acre size range which were visited each March through 1960 to obtain production, resource allocation, and income information for the previous year. The balance of this report is based on these 21 farms on which size adjustments were not made.

TABLE 5.—January 1, 1957, Livestock Inventory, Amount, and Value of Livestock and Livestock Products Sold, Average per Farm on 29 Sample Farms, 1957, by Type of Farm.

Item	Unit	5 Dairy Farms	4 Beef Farms	6 Hog Farms	6 Cash Grain Farms	8 General Purpose Farms	29 Total Farms
Dairy cows on hand 1/1/57	Cow	41.4	0	4.8	3.8	13.4	12.6
All other cattle on hand 1/1/57	Head	28.0	115.0	50.7	18.7	30.2	43.4
Dairy calves sold in 1957	Head	18.4	0	1.2	2.0	2.6	4.6
Value	Dollar	281	0	35.0	40	33	73
Fat cattle sold in 1957	Head	.2	74.5	15.2	7.3	15.5	19.2
Value	Dollar	40	17738	2791	1538	2871	4141
All other cattle sold in 1957	Head	18.2	30.5	9.7	1.0	9.8	12.2
Value	Dollar	3536	6136	1547	152	1154	2126
Milk sold in 1957	Cwt.	3459	0	268.7	258.7	1015.9	985.8
Value	Dollar	13367	0	940.6	980	3537	3678
Hogs: Sows on hand 1/1/57	Sow	7.8	1.0	25.0	4.8	7.4	9.6
Other hogs on hand 1/1/57	Head	54.6	58.5	189.0	34.8	57.8	79.7
Fat hogs sold in 1957	Head	89.8	89.5	401.7	40	103.5	147.8
Value	Dollar	3527.8	3463	16213	1581	3970	5863
Other hogs sold in 1957	Head	8.4	9.2	29.2	3.8	6.0	11.2
Value	Dollar	445.4	477	1512	329.0	439	645
Stock sheep on hand 1/1/57	Head	0	0	31.5	6.0	80.4	29.9
Lambs sold in 1957	Head	0	0	25.5	1.8	90.9	30.7
Value	Dollar	0	0	460	22	1654	556
Other sheep sold in 1957*	Head	0	0	1.0	0	17.2	5.0
Value	Dollar	0	0	7	0	145	42
Wool sold in 1957	Pound	0	0	253.0	90.0	743.8	276.1
Value	Dollar	0	0	131.5	45	355	135
Hens on hand 1/1/57	Hen	0	5.5	81.3	40.3	214.4	85.1
Chickens sold in 1957	Head	0	0	52.0	8.3	193.6	65.9
Value	Dollar	0	0	32	10	111	39
Eggs sold in 1957	Dozen	0	0	965.0	46.0	2436.5	881.3
Value	Dollar	0	0	267	18	762	269

*Cases where a ram was bought and a ram was sold during the year are not included.

OTHER ADJUSTMENTS ON 21 SAMPLE FARMS, 1958-1959[5]

Adjustments in Land Use

Significant adjustments in land use were made in 1958 and 1959. Results are shown in Table 6. Corn showed a net increase of 17 acres and soybeans increased 36 acres for the 21 farms over the 2-year period. Large net acreage increases were observed for oats and wheat as well as large reductions in the acreage reserve of the soil bank as this provision of the soil bank program was withdrawn in 1959. In 1958, corn acreage was reduced 123 acres and oats and soybeans increased 74 and 36 acres, respectively. In 1959, when the acreage reserve program was discontinued, corn increased 140 acres and wheat regained 68 acres.

[5]Adjustments in 1957 were omitted because 1956 data were not available for comparison.

Mean acreage indexes of each crop raised on the 21 sample farms are plotted in parts A, B, C, D, and E of Figure 2, along with the index of average quarterly Ohio prices of the product. The seasonal price fluctuations have been modified by using the mean of the 1950-1962 quarterly prices as the base of 100. The enterprise size index has 1957=100. The corn acreage decline in 1958 and increase in 1959 were generally associated with degree of soil bank participation. Some of the crop production curves in Figure 2 (corn in 1958 and 1959 and soybeans in 1959) show weak response to price changes occurring in the 6 to 8 months before planting time. However, most show no response to price changes.

Adjustments in Livestock Production

Increases or decreases in the size of livestock enterprises on the 21 sample farms assume somewhat the same pattern as shown for crop enterprises (Table 7). However, both spring and fall hog pro-

TABLE 6.—Significant Crop Acreage Adjustments on 21 Sample 320-Acre Farms, by Major Crop, 1958-59.*

Crop	1958			1959			Net Acreage Increase 1958-59†
	Number of Adjustments	Total Acreage Changed	Net Acreage Increase	Number of Adjustments	Total Acreage Changed	Net Acreage Increase	
Corn	8	219	—123	8	264	+140	+17
Oats	9	224	+ 74	8	84	+ 12	+86
Soybeans	6	122	+ 36	0			+36
Wheat	7	157	— 13	4	96	+ 68	+55
Hay	4	89	— 17	4	93	— 7	—24
Corn soil bank	2	30	+ 10	2‡	31	— 31	—21
Wheat soil bank	2	65	— 9	3‡	72	— 72	—81

*Acreage adjustments within a given crop enterprise may be an increase or decrease of acreage for that crop for that year. In some cases, a farmer might increase acreage of one crop and decrease acreage of another crop. This is included as two separate adjustments. Only significant changes are classified as "adjustments."

†The sum of this column does not equal 0. One farmer cash rented an additional 72 acres in 1959 and this increase is included in the net acreage increase for 1958-59.

‡The soil bank alternative for corn or wheat ground was not available in 1959 so all acreage diverted in 1958 reverted to crop use in 1959.

TABLE 7.—Significant Livestock Enterprise Adjustments on 21 Sample 320-Acre Farms, by Kind of Livestock, 1958-59.*

Kind of Livestock	1958			1959			Net Number Head Increase 1958-59
	Number of Adjustments	Number Head Changed	Net Number Head Increase	Number of Adjustments	Number Head Changed	Net Number Head Increase	
Dairy cows	0			3	36	+ 22	+ 22
Beef feeders	5	170	—14	4	298	+186	+172
Spring farrowed sows	3	63	+19	8	124	— 28	— 9
Fall farrowed sows	4	89	+89	10	201	—185	— 96
Ewes	2	52	—34	0			— 34
Hens	3	362	—78	0			— 78

*Where an operator significantly increases number of livestock in one enterprise and significantly decreases numbers in another enterprise, one adjustment is shown for each of the two changes.

TABLE 8.—Average Indebtedness on 21 Sample Farms, Jan. 1, 1957 through Jan. 1, 1960.

Number of Borrowing Farmers and Their Average Indebtedness as of Jan. 1								
	1957		1958		1959		1960	
Type of Indebtedness*	No. Farmers	Av. Debt	No. Farmers	Av. Debt	No. Farmers	Av. Debt	No. Farmers	Av. Debt
Real Estate	6	$20,867	8	$16,966	7	$17,910	7	$16,384
Short Term	12	7,487	10	8,335	12	8,651	13	8,218

*These types are not mutually exclusive Some farmers had both types of debt

duction responded sharply to price changes. Sheep production responded somewhat less markedly than hogs. Beef feeder and spring and fall pig enterprises showed adjustments on 9, 11, and 14 farms, respectively, during the 1958-1959 period. Major net adjustments in livestock numbers on the 21 farms were a plus 172 for feeder cattle and a minus 96 for fall-farrowed sows. Net changes for other types of livestock enterprises were relatively small over the 2-year period.

While livestock production adjustments conformed fairly closely to average annual product price changes in hog and sheep enterprises, no adjustment by the group is clearly noticeable for the other livestock enterprises (F, G, H, I, J, and K of Figure 2).

Adjustments in Debt Patterns

The 21 sample operators were examined for capital adjustment by means of change in debt pattern. Average indebtedness for these farms is shown in Table 8. Average size of real estate mortgage debt gradually decreased from 1957 through 1959 except during 1958, when one operator in the group paid off an existing land mortgage and the average size of mortgage increased. The only adjustments in real

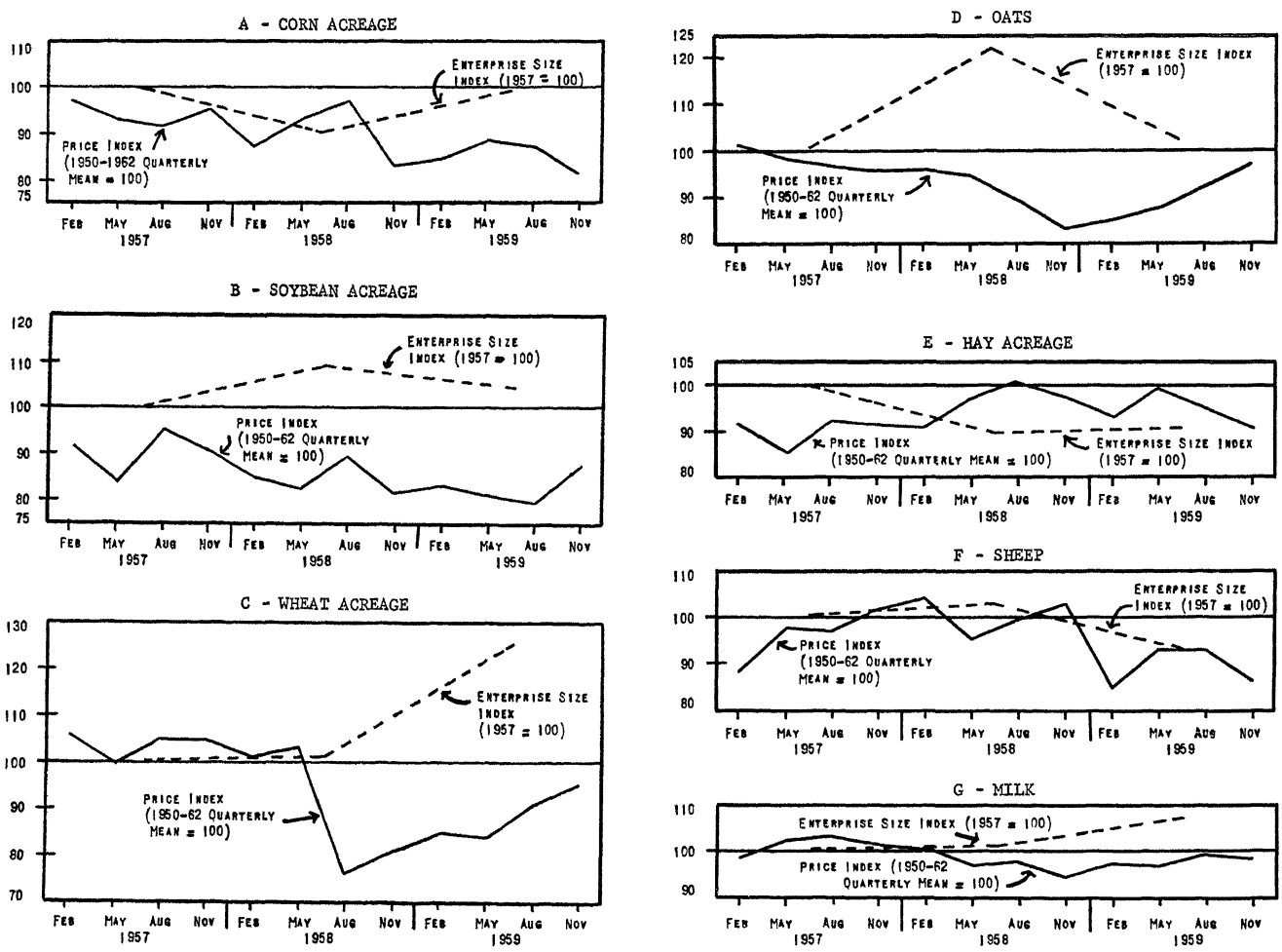

Fig. 2.—Indexes of enterprise size and product prices, 1957-1959, on 21 sample 320-acre farms.

estate mortgages occurred when two farmers added substantial mortgages in 1957.

Short-term indebtedness per farm tended to increase each year until 1959. Ten short-term debt adjustments (large increases or decreases in short-term debt) took place on the 21 sample farms during the study period. Table 9 shows that adjustment in short-term debt size was downward in 1957 and upward during 1958 and 1959.

TABLE 9.—Short-term Debt Adjustments on 21 Sample Farms, 1957-1959.

Item	During Calendar Year		
	1957	1958	1959
No of adjustments	6	1	3
Total change	$37,151	$1,500	$10,990
Net debt increase	— 12,449	1,500	4,990
Total net debt increase during 1957-59 period was			—$5,959

Adjustments in Labor

Farmers reported an average of 10.9 and 8.0 hours' work per day by the operator during the busy and slack seasons, respectively. The 21 sample farmers reported an average of 2.9, 2.3, and 2.5 man-months of unpaid family labor in addition to the operator's labor during 1957, 1958, and 1959, respectively.

Seven sample operators hired a full-time man on a yearly basis. All operators hired some seasonal labor during peak work periods, averaging 55.5 days per farm in 1957, 43.5 days in 1958, and 56.9 days in 1959.

Adjustments were made from time to time in the form of unpaid family labor leaving the farm, an operator increasing or decreasing amount of off-farm employment, or reduction of labor hours through custom hire, exchange machine work, or substantial change in the amount of hired labor. Over the 3-year period, nine operators made 12 labor adjustments.

The total productive man work units (PMWU —the amount of work done in 10 hours by a man of average efficiency) were computed for each farm for each year and divided into the annual hours of labor

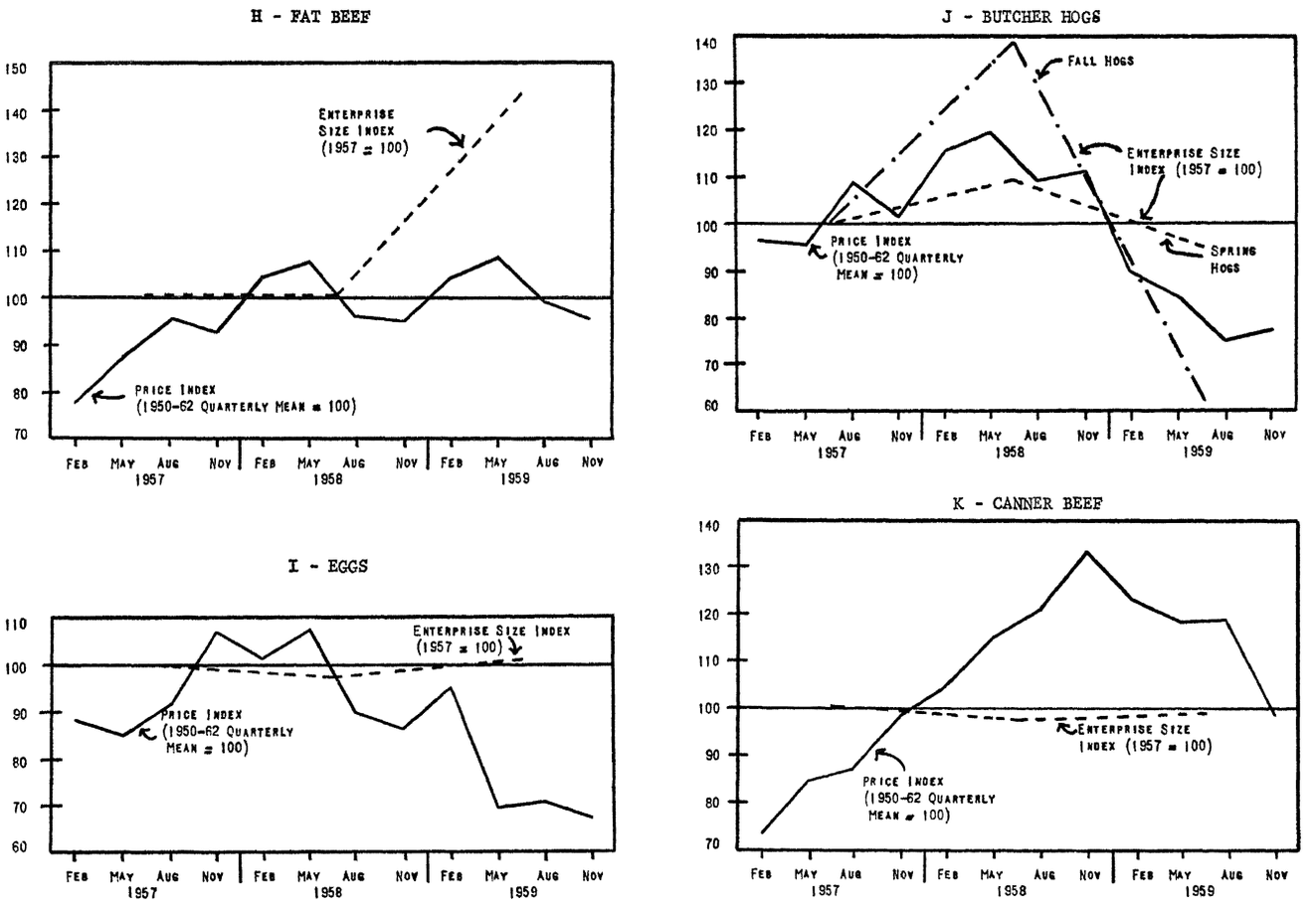

Fig. 2.—Indexes of enterprise size and product prices, 1957-1959, on 21 sample 320-acre farms.

used per farm. The average for all farms for 1957-1959 was 10.52 hours of labor used per PMWU, ranging from 10.88 in 1957 to 10.23 in 1958. This was quite consistent with the commonly accepted rate of 10 hours per PMWU, thus indicating that as a group the sample farmers were average in labor efficiency.

Adjustments in Machinery Use

Average depreciated machinery inventories as of January 1 in 1957, 1958, and 1959 were $5,898, $5,370, and $4,967, respectively. When divided by the average of 231 acres of cropland per farm, the machine investment per crop acre averaged $25.77, $23.46, and $21.70 for the 3 years. Machine investment per crop acre ranged from $6.13 on one farm to $81.30 on another.[6]

Numbers of major machines on the sample farms at the beginning and end of the 1957-1959 period are shown in Table 10. Some changes can be noted in the table. Numbers of tractors, pickup balers, and field choppers increased. Changes in types of machines included the addition of three diesel tractors, a picker-sheller, three hay conditioners, and a four-row corn planter.

[6]1957 range $9.79 to $81.30, with a standard error of $14.81; 1958 range $7.55 to $71.69, with a standard error of $13.49; 1959 range $6.13 to $53.73, with a standard error of $10.66.

The sample farmers bought more machinery during the years in which their cash receipts were highest. For example, in 1958 cash receipts per farm increased $2,240 above 1957 and the difference paid on machinery purchases per farm increased $657 over 1957. This can be seen in Figure 3, where machinery purchases are shown as a percentage of the 1957 inventory plus 100 percent. January 1 machinery inventories, cash receipts of the sample farmers, and cash receipts of all Ohio farmers are also shown in index form, with 1957 as the base year.

Average annual cost of custom work hired by the operators amounted to about $200, primarily for harvesting operations. The sample farmers who owned harvesting machines performed relatively little off-farm custom machine work for others. Table 11 shows the amount of custom machine work hired "in" and "out" on the sample farms, by years and by type of custom machine. No particular adjustment pattern is discernible, although Table 11 indicates that the annual amount spent for custom machines tended to vary inversely with cash receipts from farming.

All machinery adjustments on the sample farms were counted. A total of 26 significant changes were noted, with ten operators making changes in

TABLE 10.—Number of Major Machines on 21 Sample Farms at the Beginning of 1957 and 1960.

Kind of Machine	Size Rating	Jan. 1 1957	Jan. 1 1960
Tractor: Gasoline	All	55	59
Gasoline	1 bottom	3	3
Gasoline	2 bottoms	26	28
Gasoline	3 bottoms	25	23
Gasoline	4 bottoms	0	1
Diesel	2 bottoms	1	1
Diesel	3 bottoms	0	2
Diesel	4 bottoms	0	1
Baler	1 man	14	17
Combine: Pull type	5-8 feet	17	18
Self-propelled	8-12 feet	2	0
With corn head		1	1
Cornpicker: Pull type	1 row	6	5
Pull type	2 row	6	4
Mounted	2 row	6	8
Picker-sheller		0	1
Field chopper		8	10
Corn planter	2 row	12	14
	4 row	9	10
Sprayer	6 row	14	15
Truck	1-2 ton	15	14
Pick-up	½-¾ ton	6	8
Hay crusher or crimper		0	3

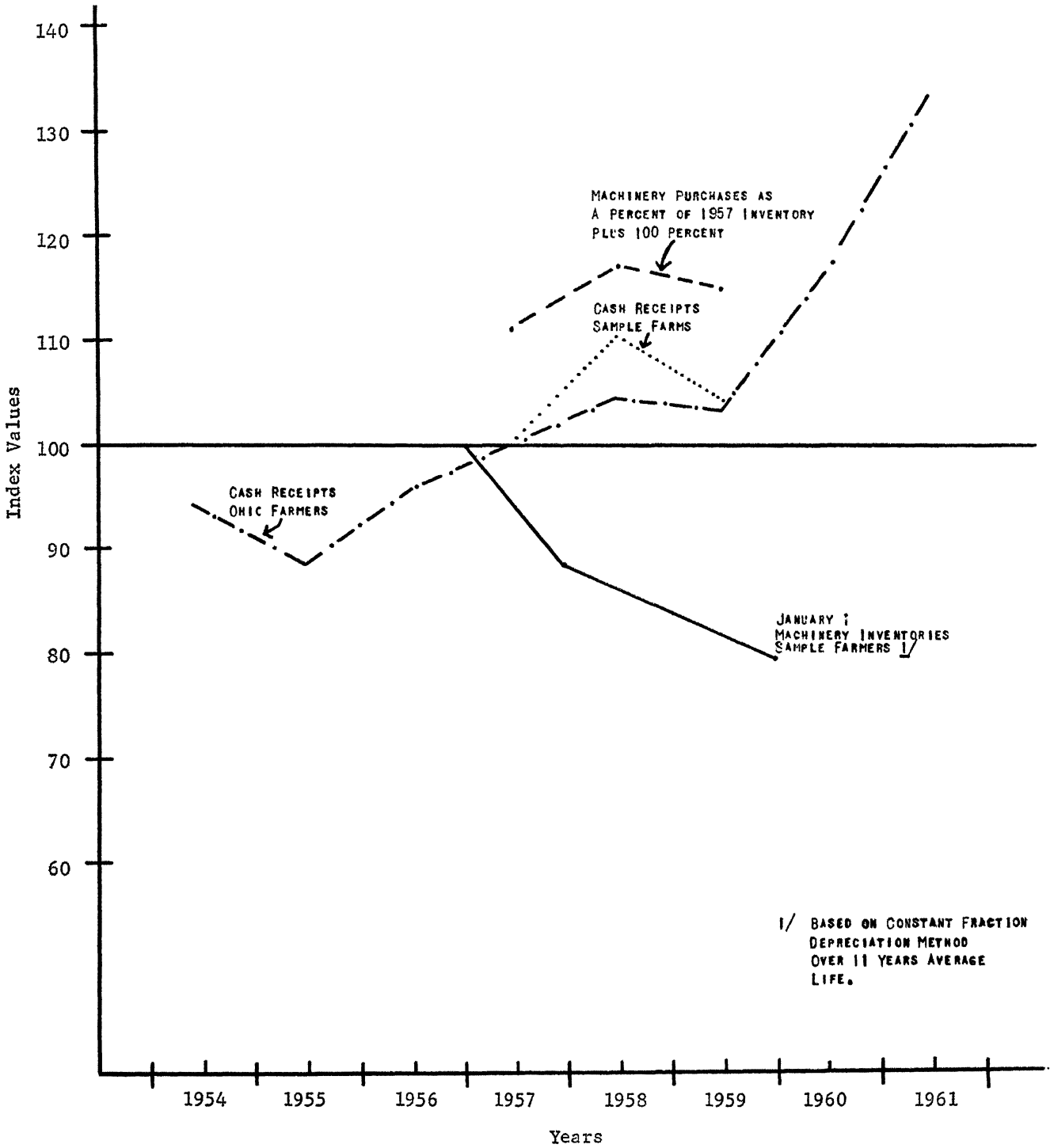

Fig. 3.—Indexes of changes in labeled items, 1954-1961.

1958 and seven in 1959. These adjustments were primarily the purchase or sale of major machines other than for replacement and substantial changes in amounts of custom work done off-farm by the operator or on-farm hired by the operator.

Adjustments in Technology

Many operators made significant changes in production methods by adopting some new technique or machine which the operator had not previously used. Other operators substantially increased or decreased use of some input, such as fertilizer, as compared with the previous pattern of use.[7] These were classified as technological adjustments.

It was somewhat difficult to draw a line between machinery and technological adjustments. The criterion used was that an adjustment was technological if the type of machine was new to the operator; it was a machinery adjustment if the operator had similar machines already on the farm. For example, if the operator had previously owned a gasoline tractor, the addition of a diesel tractor was considered a technological change while the purchase of another gasoline tractor was considered a machinery adjustment.

The technological adjustments[8] and the number of sample operators adopting each innovation during 1958 and 1959 were: six operators significantly changed amount of fertilizer used; three farmers exchanged gasoline tractors for diesel units; three farmers added hay conditioning equipment; self-unloading type wagons were introduced on three farms; two dairy operators initiated artificial insemination; two new bulk tanks were installed; two operators began spraying corn, with one of them purchasing a new

[7]Unfortunately, the operators were not questioned as to the variety of seeds they used, so that particular type of innovation is not included in technological adjustments.

[8]The mean absolute value of the magnitude of the adjustments was $1,107, with a standard error of $454.

TABLE 11.—Use of Major Harvesting Machines, Custom Hired and Performed Off-Farm by Operators, by Years, on 21 Sub-Sample Farms.

		1957		1958		1959	
	Unit	Number of Farms*	Total	Number of Farms*	Total	Number of Farms*	Total
Combining							
On own farm	Acre	21	1,307	20	1,446	20	1,438
For others	Acre	2	90	1	30	1	77
Custom hired	Acre	3	42	3	67	3	85
Baling†							
On own farm	Acre	15	920	17	848	18	1,138
For others	Acre	1	40	1	42	1	25
Custom hired	Acre	7	278	5	235	4	160
Corn picking							
On own farm	Acre	21	1,587	21	1,447	21	1,572
For others	Acre	1	25	0	0	0	0
Custom hired	Acre	3‡	24	2‡	5	4‡	31
Spraying							
On own farm	Acre	**		**		**	
For others	Dollar	0	0	0	0	0	0
Custom hired	Dollar	0	0	1	33	2	95
Silo filling							
On own farm	Acre	8	150	11	221	13	249
For others	Dollar	2	405	0	0	1	95
Custom hired	Dollar	5	911	3	510	2	230
Other custom							
For others	Dollar	1	500	1	350	1	700
Hired	Dollar	9	1,381	3	325	7	2,479
Total receipts from custom work	Dollar	1,775		835		1,361	
Total cost of custom machines	Dollar	4,418		3,618		5,089	
Index of cash farm receipts		100		110		104	

*Includes a few machines owned by other than sample operator but used on an exchange basis.

†The acreages are weighted to give acreages of first cutting equivalents: 2nd cutting and straw = ½; 3rd cutting = ¼.

‡Some operators with pull type pickers hire a custom mounted picker to open corn fields.

**Information was not obtained from the operators.

sprayer; one operator installed a grain drying unit; and one farmer put in a large feed conveyer system.

A total of 23 technological adjustments were made by 14 farmers. Four operators recorded two adjustments each and two other operators made three and four adjustments. Undoubtedly other significant technological changes were made by these sample farmers during the period but were not recorded. It is interesting to note that 14 of the 23 technological adjustments were concerned with machinery or equipment.

Adjustments in Cash Costs

Figure 4 shows an index of operator's annual total cash costs, an index of prices paid by farmers for production items,[9] and an index of prices received by Ohio farmers. The index of prices paid continued to rise after 1958 and the prices received index declined.

The average cash costs per farm in the study were $10,906, $11,837, and $12,132 for 1957, 1958, and 1959, respectively. Cash costs on hog farms ranged from $13,686 in 1957 to $15,510 in 1958 and were the highest per farm of any farm type studied in each of the 3 years.[10] Dairy farms were second highest each year, with average total cash costs of $9,259, $10,231, and $10,041 for 1957, 1958, and 1959, respectively. General livestock farms averaged $9,140 per year.

Each farm was examined in 1958 and 1959 to determine the number of significant departures from the normal pattern of cash costs. A substantial decrease or increase in total cash costs in a given year

[9]Taken from 1962 Agricultural Statistics, USDA. The U. S. figures were used because an Ohio index was not available.

[10]Costs were highest on beef farms but there were only two farms in that class. Their costs were $14,009, $15,674, and $18,646 for 1957, 1958, and 1959, respectively.

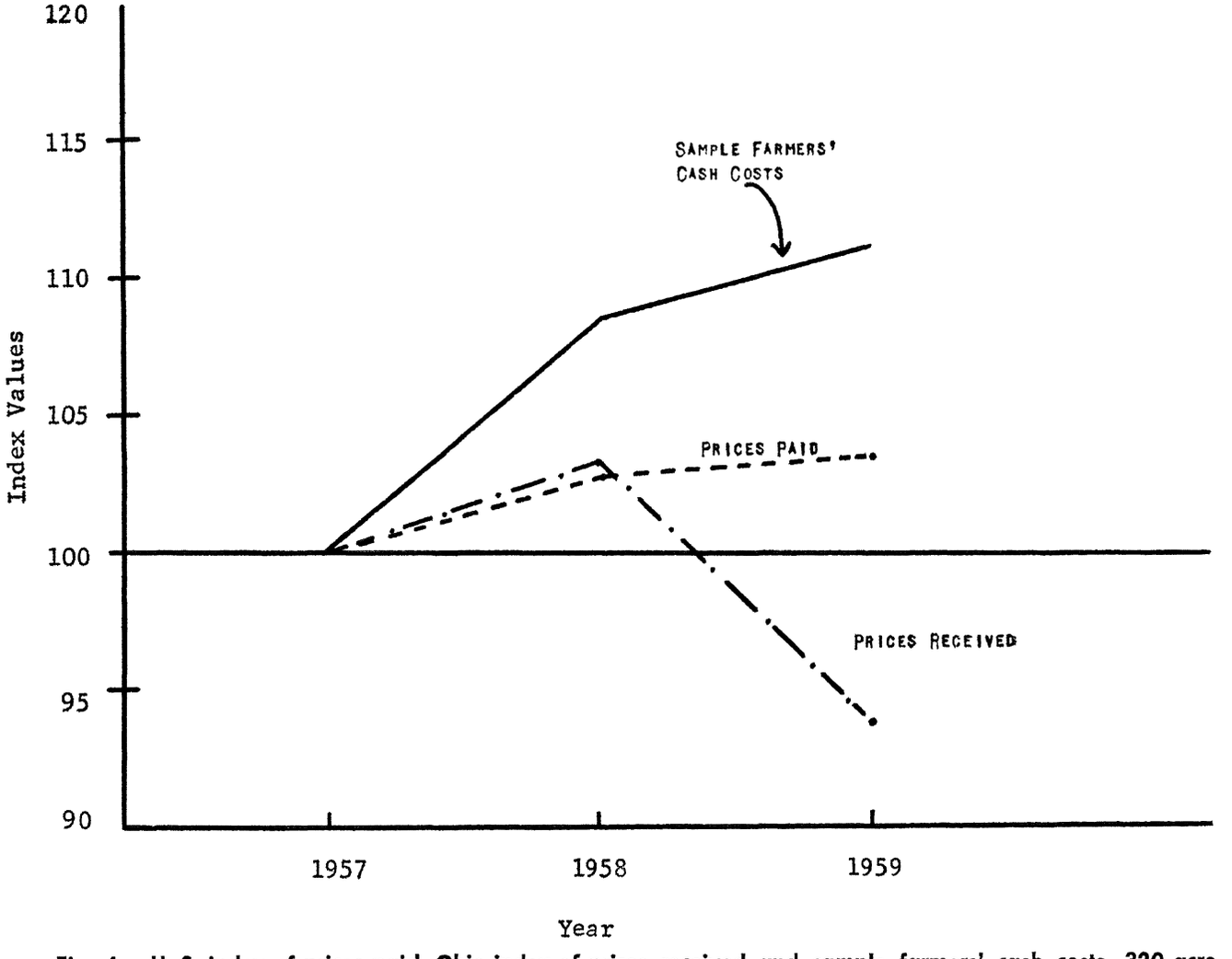

Fig. 4.—U. S. index of prices paid, Ohio index of prices received and sample farmers' cash costs, 320-acre farms, 1957-1959. 1957=100.

constituted a cost adjustment for that farm. During this period, only five operators made significant cost adjustments[11] and all were reductions in costs in 1959. The "sample farmers' cash costs" line in Figure 4 reflects this as costs continued to climb, although at a somewhat reduced rate in 1959.

Adjustments in Improvements

This group of adjustments includes major additions to buildings, new buildings, or unusually large expenditures on land improvements. A total of 17 adjustments[12] were made during 1958 and 1959. They were: four new buildings and an addition to an existing building, construction of two new silos and an addition to an existing silo on two farms, extensive tiling on five farms, paving two feeding lots on one farm, and substantial electrical improvements on two farms.

Analysis of Adjustments by Type of Farm

The sample farms were arrayed according to number of adjustments of all types per farm during 1958 and 1959. The range was from 15 to 4, with a mean of 8.95. Dairy farms averaged 8.83 per farm; hog farms, 8.50 per farm; and general livestock farms, 8.71 per farm.[13] By use of group comparison methods, the number of adjustments on dairy and hog farms were tested against the entire group mean and against each other. The "t" values were not significant, indicating that the number of adjustments does not differ by farm type.

The distribution of adjustments was tested for normality. One and two standard deviations on either side of the mean contained 66.67 percent and 95.24 percent, respectively, of the observations. Comparing this with the standard 68.24 and 95.45 percent of the normal distribution, the numbers of adjustments are normally distributed.

FACTORS RELATED TO ADJUSTMENTS

Influence on Adjustments

A number of possible influencing factors were tested by means of correlation procedures to determine associations between these factors and adjustments.

These factors were considered as independent variables (X_1—X_{26}). The previously discussed types of adjustments and their total were the dependent variates (Y_1—Y_9). The 26 independent variables used were:

X_1 —number of crop acres per farm
X_2 —amount of labor in most restricted month
X_3 —annual amount of unpaid labor
X_4 —amount of capital available
X_5 —operator's percent equity in the business
X_6 —value of operator's equity in the business
X_7 —number of animal units of livestock
X_8 —number of price map areas per farm
X_9 —normal selling month price of fat hogs in fall this year minus last year
X_{10}—previous year normal selling month price of fat hogs in fall minus 2 years ago
X_{11}—normal selling month price of fat hogs in spring this year minus last year
X_{12}—previous year normal selling month price of fat hogs in spring minus 2 years ago
X_{13}—normal selling month price of fat cattle this year minus last year
X_{14}—last year's normal month selling price of fat cattle minus 2 years ago
X_{15}—2 years ago normal month selling price of fat cattle minus 3 years ago
X_{16}—cost of fertilizer and lime used
X_{17}—current year's average price of milk per hundredweight minus last year's price
X_{18}—last year's average price of milk per hundredweight minus average price 2 years ago
X_{19}—corn price received at major selling time this year minus price at that time last year (if none were sold, closing inventory values were used)
X_{20}—previous year's labor income
X_{21}—previous year's cash costs per PMWU
X_{22}—age of operator
X_{23}—education of operator
X_{24}—amount of re-investment over annual commitment in the farm business
X_{25}—current year's cash costs
X_{26}—current year's cash costs per PMWU

The results of the correlations are shown in Table 12. The simple correlation coefficients, with significance level designated, are indicated.

Total adjustments were significantly related to the re-investment policy of the operator, the operator's cost efficiency index (cost per PMWU), and the cash cost level of the current year. Changes in hog and milk prices over the previous year or two also were associated with the number of total adjustments the

[11]The mean absolute magnitude of the adjustments was $2,867, with a standard error of $1,148.

[12]The mean size of the expenditure involved was $1,687, with a standard error of $1,467.

[13]Two beef feeder farms averaged 11.5 adjustments. However, because of the small number of observations in this farm type, dairy farms were designated as the farm type group with the greatest number of adjustments.

operator was likely to make during the coming production year.

Cropping adjustments and *labor adjustments* were both significantly related to changes in hog and milk prices over the previous 2-year period. *Livestock adjustments* were also significantly related to changes in livestock and milk prices but were correlated even more highly with the operator's cost efficiency of the previous and current year.

The number of *machinery adjustments* correlated significantly with the operator's policy of re-investment in the farm business over and above his committed cash outlays. The level of cash costs per PMWU of the previous year was also significantly associated with the number of *machinery adjustments* the operator was likely to make during the current production year.

Adjustments in cash costs were significantly associated with the movement of hog and corn prices during the past year.

Improvements adjustments were related to much the same factors as *machinery adjustments.* Significant correlations were found with the operator's cost efficiency of the current and previous year, with the operator's policy of re-investment in the farm, and with favorable hog price changes 2 years before.

The characteristics associated with many types of adjustment were: (1) changes in livestock and milk prices; (2) level of cash cost and cost efficiency; and (3) the operator's policy of re-investment in the farm business over and above committed cash outlays.

In most cases of significant correlation between price changes and adjustments, there was a negative association of the price change from the previous year and the current year and a positive correlation of the price change from 2 years ago to the previous year. This indicates that operators adjust to price changes but only after a 1-year lag and an indication of a trend has been established. In other words, they do not adjust to extremely short run price fluctuations.

TABLE 12.—Correlation of 26 Independent Variables with Adjustment Types, 1958-59.

Independent Variables	Dependent Variables‡								
	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
Number of crop acres	—.13	.03	.05	—.15	.17	—.21	—.10	.12	—.05
Hours of labor in most restrictive month	.06	—.05	.03	—.20	.19	—.04	.10	.18	.07
Hours of unpaid labor	—.11	.07	.12	—.10	—.10	—.13	.06	.19	.04
Capital available	.04	—.04	.24	—.25	.21	.01	.00	.15	.16
Percent equity	—.13	—.12	.10	.15	.04	—.20	—.08	—.14	—.18
Net worth	.01	—.11	.34*	—.07	.14	—.02	—.14	.11	.12
Animal units of livestock	.18	—.11	.26+	—.22	—.02	.02	.02	.13	.12
Number of price map areas	—.07	—.14	.10	—06	—.07	—.04	.13	—.04	—.10
Fall hog prices, this year-last year	—.00	.37*	—.26+	—.20	.17	—.01	—.30+	—.20	.01
Fall hog price, last year-2 years ago	—.16	.22	.04	—.08	.31*	.21	—.10	.25	.32*
Spring hog price, this year-last year	—.10	.35*	—.25	—.23	.13	.05	—.32*	—.08	.03
Spring hog price, last year-2 years ago	—.06	—.09	.17	.00	.26+	—.03	.05	.31*	.16
Fat cattle price, this year-last year	.24	.09	.08	—.06	.07	.00	—.26	.10	.17
Fat cattle price, last year-2 years ago	.13	—.18	.15	—.07	.09	—.27+	.07	—.14	—.15
Fat cattle price, 2 years ago-3 years ago	—.11	.07	—.12	—.05	.05	.22	—.10	—.04	.03
Cost of fertilizer and lime	.31*	—.07	.24	—.17	.15	—.09	—.05	—.11	.09
Milk price, this year-last year	.14	—.34*	—.22	.06	—.30+	.06	.19	—.11	—.31*
Milk price, last year-2 years ago	—.22	.31*	.27+	—.17	.38*	—.14	—.24	.25	.30*
Corn price, this year-last year	.06	.10	—.18	—.25	.22	.23	—.27+	—.03	.06
Last year's labor income	—.03	.00	.14	—.11	—.08	—.01	.21	.14	.10
Last year's cash costs per PMWU	.01	—.30+	.49**	—.03	.14	.33*	.03	.38*	.34*
Age of operator	—.07	—.17	—.05	—.03	.08	.00	—.06	—.09	—.17
Education of operator	.04	.01	.39*	—.17	—.10	—.00	—.00	.04	.15
Amount of re-investment over annual commitment	.22	.12	—.04	—.09	.15	.41**	—.25	.34*	.41**
Current year's cash costs	.10	—.09	.38*	—.22	.29+	.21	—.13	.31*	.36*
Current year's cash costs per PMWU	.02	—.19	.56**	—.15	.22	.21	—.19	.27+	.30+
R_2	.85	67	.94**	.70	.78	.83	.79	.90*	.81
R	.72	.45	.89	.50	.61	.69	.63	.82	.66

‡Identification of the dependent variables (Y_1 through Y_9) is shown in Table 13.

+Significant at 0.10 level of probability.

*Significant at 0.05 level of probality.

**Significant at 0.01 level of probability.

TABLE 13.—Correlations Between Types of Adjustments, 1958-59.

Types of Adjustment	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9
Technological (Y_1)	———	0 04	—0 25	0 01	0.09	0.33*	0.07	—0.18	0.35*
Cropping (Y_2)		———	— .10	— .15	.19	— .06	— .33*	— .02	.53**
Livestock (Y_3)			———	— .09	— .07	.12	— .17	.20	.36*
Capital (Y_4)				———	— .18	— .13	.38*	.01	— .03
Labor (Y_5)					———	— .07	— .21	.02	.27+
Machinery (Y_6)						———	— .17	.06	.52**
Cash Cost (Y_7)							———	.17	— .12
Improvement (Y_8)								———	.41**
Total (Y_9)									———

+Significant at 0 10 level of probability.
*Significant at 0.05 level of probability.
**Significant at 0 01 level of probability.

In all but one case, the significant correlations between adjustments and cash cost level and relative cost efficiency were positive. Thus it is concluded either that operators are sensitive to changes in costs or that adjustments result in higher total cash costs of operation. Livestock adjustments and improvements adjustments are the particular types of change which are likely to be made.

The amount of re-investment in the farm business over annual commitment for expenditures was significantly correlated in a positive manner with *machinery adjustments* and *improvements adjustments*. This indicates that the re-investment was being spent for machinery and improvements.

Supplemental correlations were also run involving the associations between the various types of adjustments (Y_1 through Y_9). These are shown in Table 13. The association of *total adjustments* with each type of adjustment was expected as Y_9 is the sum of Y_1 through Y_8. *Technological adjustments* and *machinery adjustments* were significantly correlated at the 0.05 level of probability. This relationship is logical since one type of adjustment may be made as a result of the other or in order to make the other type of change.

Effects of Non-economic Factors on Number of Adjustments

During the final interview in the spring of 1960, the sample operators were asked whether or not their decisions were influenced by certain non-economic factors to the extent that a probable more profitable alternative was rejected. Of some 12 items in the list, 4 were found to influence operator decision-making more than the others. These were: (1) personal preference of the operator; (2) operator's aversion to borrowing money (even if funds are available and could be borrowed); (3) competition of the household for funds available for investment in the farm business; and (4) reluctance of the operator to give up part of his existing leisure time.

The operators who answered no to each question were placed in one group and those who replied yes were included in a second group. Group comparison techniques were used to test homogeneity of the two groups with respect to numbers of adjustments made by the operators during the 1958-59 period. Results were tested for statistical significance by the "t" test.

Five of 20[14] operators from whom answers were received replied no on the influence of "personal preference of the operator." These five made 58 (11.6 per operator) adjustments during 1958 and 1959. The 15 farmers replying yes made 122 adjustments (8.13 per operator). The difference between the mean number of adjustments for the two groups was significant at the 0.05 probability level. This indicates that farmers who adhered more closely to personal preferences were more reluctant to make major changes.

Eight of 19 operators reported that "aversion to borrowing money" did not influence their decisions. These eight averaged 10.88 adjustments and the 11 operators answering yes averaged 8.00 significant changes. This difference was also significant at the 0.05 level. Again it appears likely that this factor is closely associated with number of adjustments made.

Fifteen of 19 respondents denied being influenced by "household competition for funds." Nine of 19 operators replied no on the influence of "reluctance to give up leisure time." The differences in mean adjustments between the no and the yes groups for these two factors were statistically non-significant.

[14]One operator did not respond to this question and two answers were not obtained for each of the other three questions.

It would appear that leisure time and household competition are not associated with the operator's inclination to make adjustments.

The conclusion must be that these non-economic factors perhaps have sufficient influence to serve as stabilizers or deterrents to adjustment. More than 50 percent of the answers (40 of 77) indicated that non-economic factors influence decision-making.

DESIRABLE ADJUSTMENTS AS INDICATED BY PROGRAMMING OF SAMPLE FARMS

Variable Price Linear Programming[15]

Linear programming was used on each of the 21 sample farms to determine maximum profit resource use at varying hog and beef prices, with constant prices for crop products, milk, eggs, wool, and lamb. The non-economic factors discussed above were not considered in the programming model. A "typical" year for the period 1958-59 was programmed rather than to program each year for each farm. The programming model is shown in Appendix A.

Development of Programming Matrix

Production resources available on each sample farm served as limits to the amounts of each alternative activity which could occur. Alternative livestock activities which could be used by the operator to maximize returns included: four hog enterprises including a two-litter system, a spring litter system, a fall litter system, and the option to purchase feeder pigs; a beef-feeder program; beef cow-calf enterprise; and a dairy enterprise. The dairy system was selected from the most appropriate of several systems compared in previous work in this project.[16]

The production and cost coefficients used for each farm were taken from the 3-year history of the farm obtained in the annual enumeration of the sample operators. This was done so the coefficients were consistent with the management ability level of the particular operator. Feed practices were synthesized as typical of the area.

Prices of products used are shown in Table 14. A grade B dairy enterprise was not included as previous computations indicated it was not profitable. Investment values of dairy cows were fixed according to amount of milk production. Hogs were sold at weights between 190-230 lb., according to the practice of the individual operator. In the beef-feeding alternative, feeder calves were bought at 400 lb. and sold as fat cattle at 900 lb. Interest on fixed assets and depreciation charges were not included in determining the optimal plans but were subtracted in determining family labor earnings.

TABLE 14.—Prices Used in Linear Programming Model.

Commodity	Unit	Purchase Price	Sale Price
		Dollars	Dollars
Milk, bulk cooled	Cwt.		3.95 (net)
Milk, can cooled	Cwt.		3.80 (net)
Wool	Pound		.58
Lamb	Pound		.20
Eggs	Dozen		.33
Hens	Pound		.12
Chicks	Chick	0 30	
Corn	Bushel	1.22	1.15
Oats	Bushel	0 72	.64
Hay	Ton	21.00	20.00
Wheat	Bushel		2.00
Fat Hogs	Cwt.		10.00-28.00*
Fat Beef	Cwt.		12.00-36 00*

*In the variable pricing procedure used, these are the ranges within which prices of hogs and beef cattle were permitted to vary.

The land resource for each farm was fixed. The labor resource included operator, family, and hired labor. The capital resource was derived by adding value of breeding stock, cash on hand, and reasonable expectations of receipts less $2,000 annual living expense, committed interest, committed debt repayment, and other committed expenses. An estimate of expected receipts was included because farmers re-invest receipts during the year. So the capital resource included "borrowing" against expected income.

Programming Results: Price Mapping

The results for each programmed farm were graphed to show the changes in optimal plans associated with the changing hog and beef price relationships as other prices remained constant. This graph is called a price map. An example of a price map is shown in Figure 5. On this particular graph, the price for hogs varied from $17 to $21.50 and for beef from $20 to $27. The graph shows 23 different price areas or organization plans. Table 15 presents these 23 optimum organizations.

For example, the optimum enterprise combination for area 1 (where the hog price varies up to $17.80 and the beef price varies up to $20.85) would be 37 dairy cows, 106 acres of corn, 15 acres of oats, 71 acres of hay cut one time, and 60 acres of permanent pasture. The operator would sell 7,178 bushels of corn and 381 bushels of oats and would buy 7 tons of hay.

Within any one section of the price map, the use of available resources remains the same. Adjust-

[15]The concept of linear programming is simply the derivation of the optimum allocation of existing resources among alternative activities when costs and returns are known. In this study, the optimum allocation was taken to be that which gave maximum profit.

[16]Wescott, E R 1959. Optimum Combinations of Resources for Dairy Farms in West Central Ohio. Unpublished Ph D. dissertation, The Ohio State University, Columbus.

ments to changing price relationships move the farm organization across an area boundary into another area. However, going from a one-price map area into another area may change income only a few dollars or it may substantially affect operator income.

A large number of small price map areas for a given farm indicates more enterprise sensitivity to price change within the range of product prices considered than a small number of larger areas. A few large areas indicate that the price change necessary to cause resource shifts could be substantial relative to the price shift necessary to result in a change in resource use if there were several small areas. In other words, a given price change is more likely to cause an adjustment on a farm whose price map has many small areas Thus, the number of areas in the price map within a relevant price range suggests the price adjustment possibilities of a given farm, assuming profit maximization is the goal of the operator. Within the $12-$22 hog price range and $18-$30 beef price range for the price maps of the 21 sample farms, the range of the number of price map areas was from 12 to 55, with a mean of 24.2.

Actual and Programmed Organization Differences on Individual Farms

The individual optimum solutions were compared with the actual farm organizations for both 1958 and 1959. The optimum solution used for comparison was the programmed solution for the prices of hogs and beef received by the operator that year For example, in Table 15 plan 10 was compared with the farm's actual 1958 production and plan 12 with the actual 1959 production. Adjustments necessary to bring the farm organization into conformity with the program solutions are shown on the graphs in Figure 6.

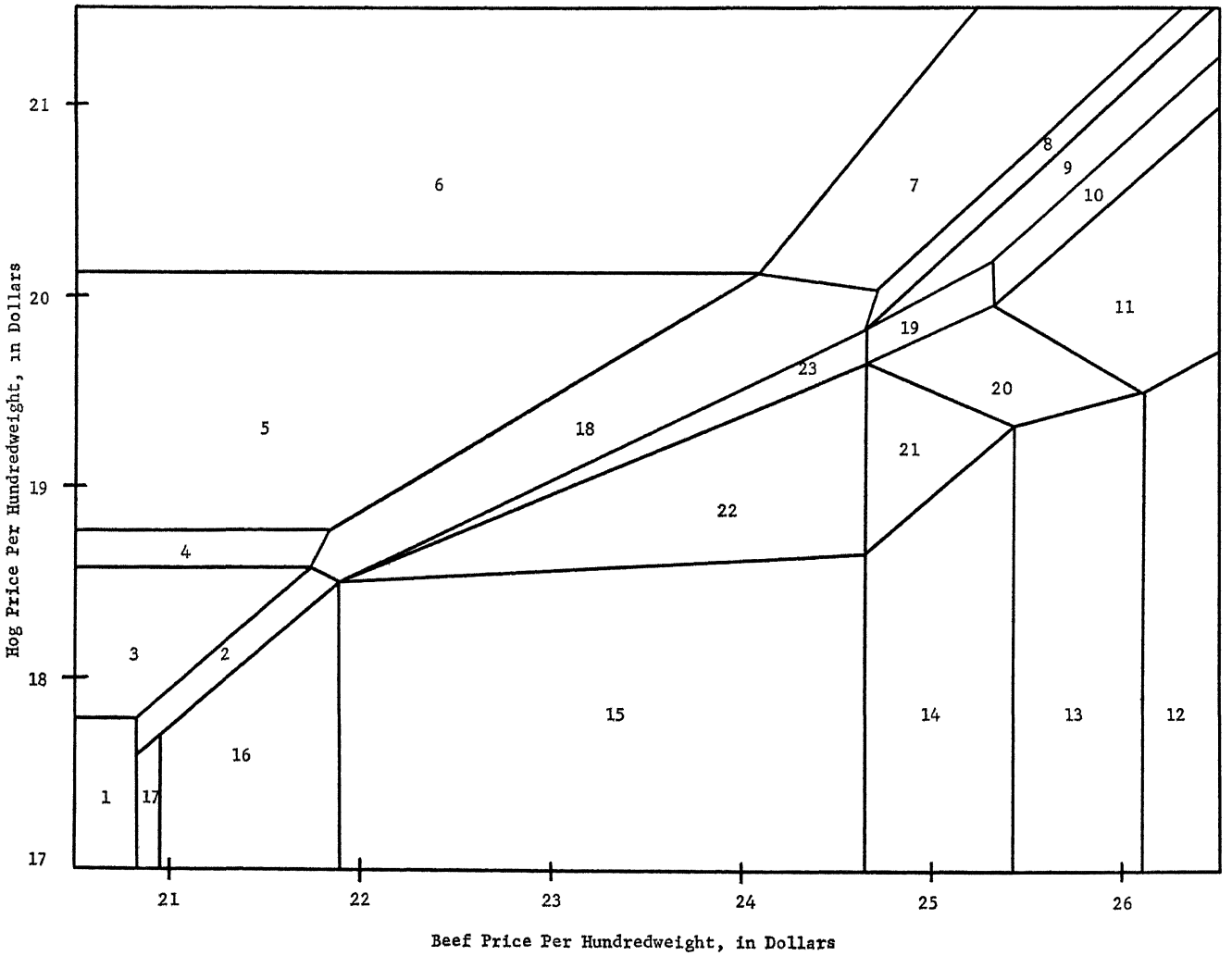

Fig. 5.—Sample price map for an individual farm.

In graph A of Figure 6, for example, it can be seen that ten farms should have increased corn acreage in 1958 and six operators should have reduced corn acreage. As mentioned earlier, off-setting adjustments take place between individual units of the group. With all sample farmers at optimum corn acreage, the net increase for the group in 1958 would have been 100 acres or about 5 acres per sample farm at the product prices actually received by each farmer that year. A similar scrutiny of 1959[17] indicates that at 1959 prices, ten operators should have increased corn acreage and nine others overplanted. The net increase for the group should have been 37 acres or about 2 acres per farm.

[1] Each year s recommended enterprise increases or decreases are based on the enterprise size actually on the farms that year They are independent of the existing or recommended amounts of the previous or succeeding year.

TABLE 15.—Optimum Organization for Price Map Areas on an Actual 320-Acre Sample Farm, with Actual Farm Organizations for 1958 and 1959.*

Resource Use Alternatives	Price Map Area Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Beef feeder (head)	0	44	0	0	0	0	93	262	279	321	345	396	340
Hogs-two litter (sow)	0	27	36	51	62	77	63	31	28	20	15	0	0
Hogs-spring litter (sow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Hogs-fall litter (sow)	0	0	0	0	0	0	0	0	0	0	0	0	0
Dairy (cow)	37	27	27	23	113	0	0	0	0	0	0	0	0
Corn (acre)	106	106	106	106	106	106	106	106	106	106	106	106	106
Oats (acre)	15	15	15	15	15	34	49	15	15	15	15	15	15
Wheat (acre)	20	20	20	20	20	20	20	20	20	20	20	20	20
Two cuttings hay (acre)	0	0	0	0	0	0	0	67	71	71	71	71	71
One cutting hay (acre)	71	71	55	47	71	52	36	4	0	0	0	0	0
Rotation pasture (acre)	0	0	16	24	0	0	0	0	0	0	0	0	0
Permanent pasture (acre)	60	60	60	60	60	60	60	60	60	60	60	60	60
Buy corn (bu)	0	0	0	2,961	4,800	7,485	8,697	9,552	9,637	9,787	9,809	8,862	6,846
Sell corn (bu)	7,176	0	0	0	0	0	0	0	0	0	0	0	0
Buy oats (bu)	0	1,140	1,462	2,226	2,599	1,674	155	1,894	1,793	1,541	1,378	765	741
Sell oats (bu)	381	0	0	0	0	0	0	0	0	0	0	0	0
Buy hay (ton)	7	0	0	0	0	0	0	0	11	42	60	97	103
Sell hay (ton)	0	0	0	0	91	104	0	0	0	0	0	0	0

Resource Use Alternatives	Price Map Area Number										Actual Farm Organization	
	14	15	16	17	18	19	20	21	22	23	1958	1959
Beef feeders (head)	313	178	163	76	73	301	327	307	178	132	183	170
Hogs-two litter (sow)	0	0	0	0	41	20	10	1	1	20	19	22
Hogs spring litter (sow)	0	0	0	0	0	0	0	0	0	0	0	6
Hogs fall litter (sow)	0	0	0	0	0	0	0	0	0	0	25	0
Dairy (cow)	16	37	37	37	21	3	7	17	37	29	0	0
Corn (acre)	106	106	106	106	106	106	106	106	106	106	120	95
Oats (acre)	15	15	15	15	15	15	15	15	15	15	35	35
Wheat (acre)	20	20	20	20	20	20	20	20	20	20	20	20
Two cuttings hay (acre)	56	0	0	0	0	71	71	54	0	0	21	35
One cutting hay (acre)	15	71	71	71	71	0	0	17	71	71	0	0
Rotation pasture (acre)	0	0	0	0	0	0	0	0	0	0	35	26
Permanent pasture (acre)	60	60	60	60	60	60	60	60	60	60	60	60
Buy corn (bu)	5,852	659	0	0	4,078	9,053	8,148	5,853	870	2,516	8,615	7,184
Sell corn (bu)	0	0	0	3,822	0	0	0	0	0	0	0	0
Buy oats (bu)	725	509	434	0	1,984	1,517	1,142	770	564	1,245	0	0
Sell oats (bu)	0	0	0	0	0	0	0	0	0	0	21	623
Buy hay (ton)	117	149	137	68	0	41	77	117	147	81	0	0
Sell hay (ton)	0	0	0	0	0	0	0	0	0	0	111	143

*The activities of beef cow-calf, feeder pigs, sheep, poultry, and soil bank, although available options, were not included in any of the optimum plans

Maximum variable family income (fixed costs not deducted) in 1958 was $20,554 and occurred in area 10 of the price map with the hog and beef price relationship as it was in 1958. Variable family income from the operator s actual 1958 organization was $17,152 With hog and beef price relationship as it was in 1959, a maximum income of $21,089 occurred in price map area 12 The farmer s income above variable costs for 1959, with the resource allocation he actually used, was $15,314

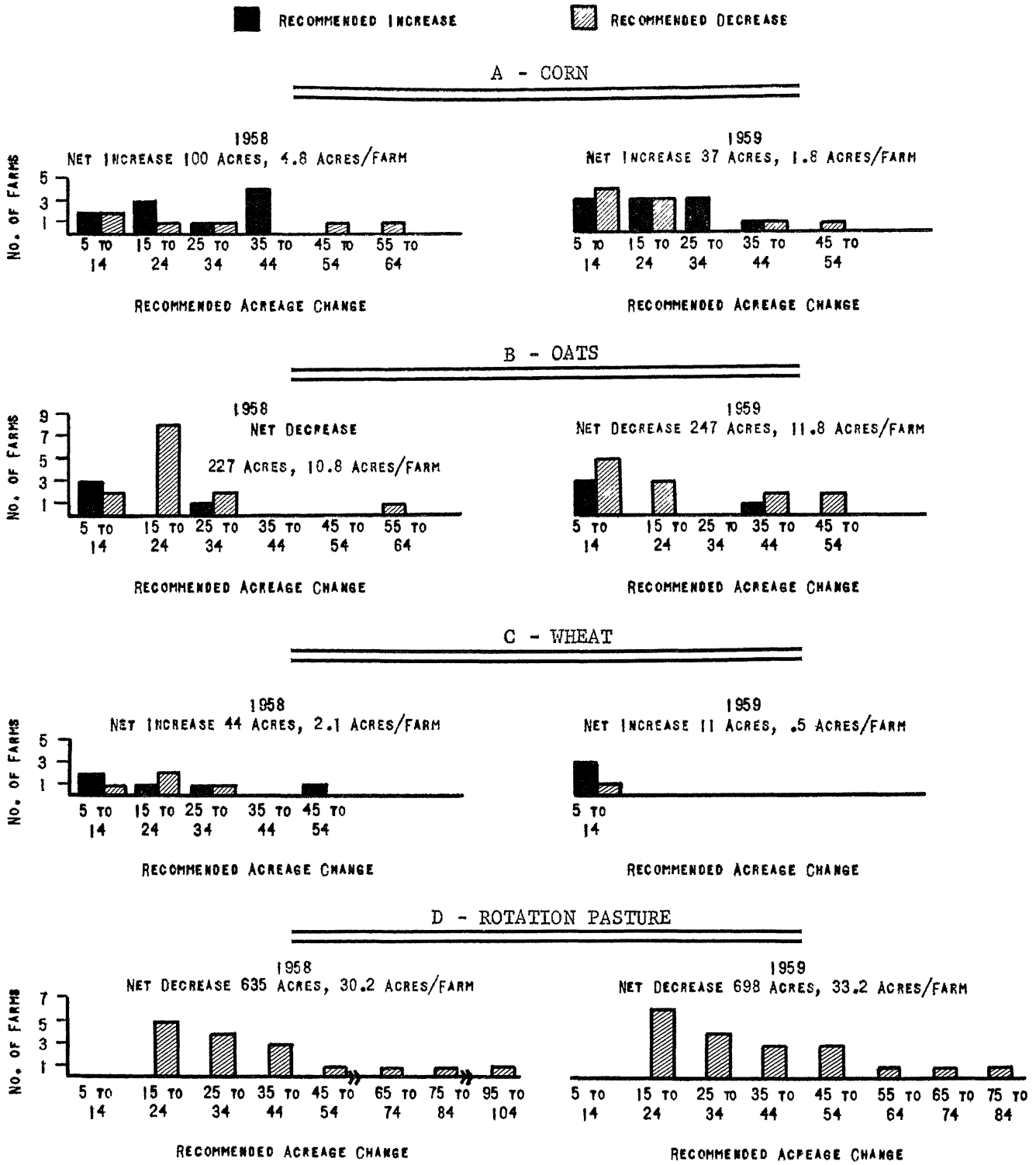

Fig. 6.—Recommended enterprise size changes necessary to conform to programmed optimum size, by number of farms, by years.

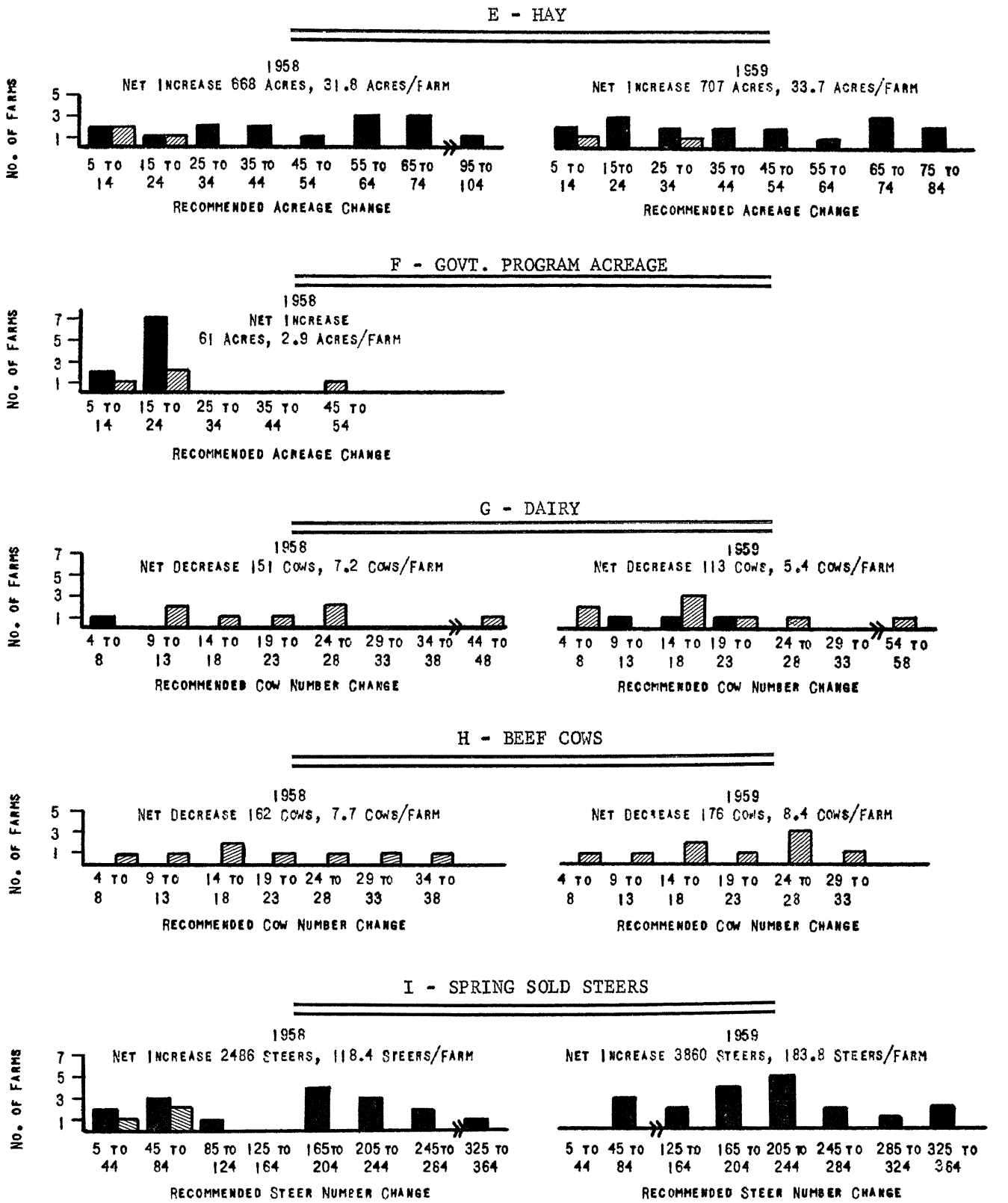

Fig. 6.—Recommended enterprise size changes necessary to conform to programmed optimum size, by number of farms, by years.

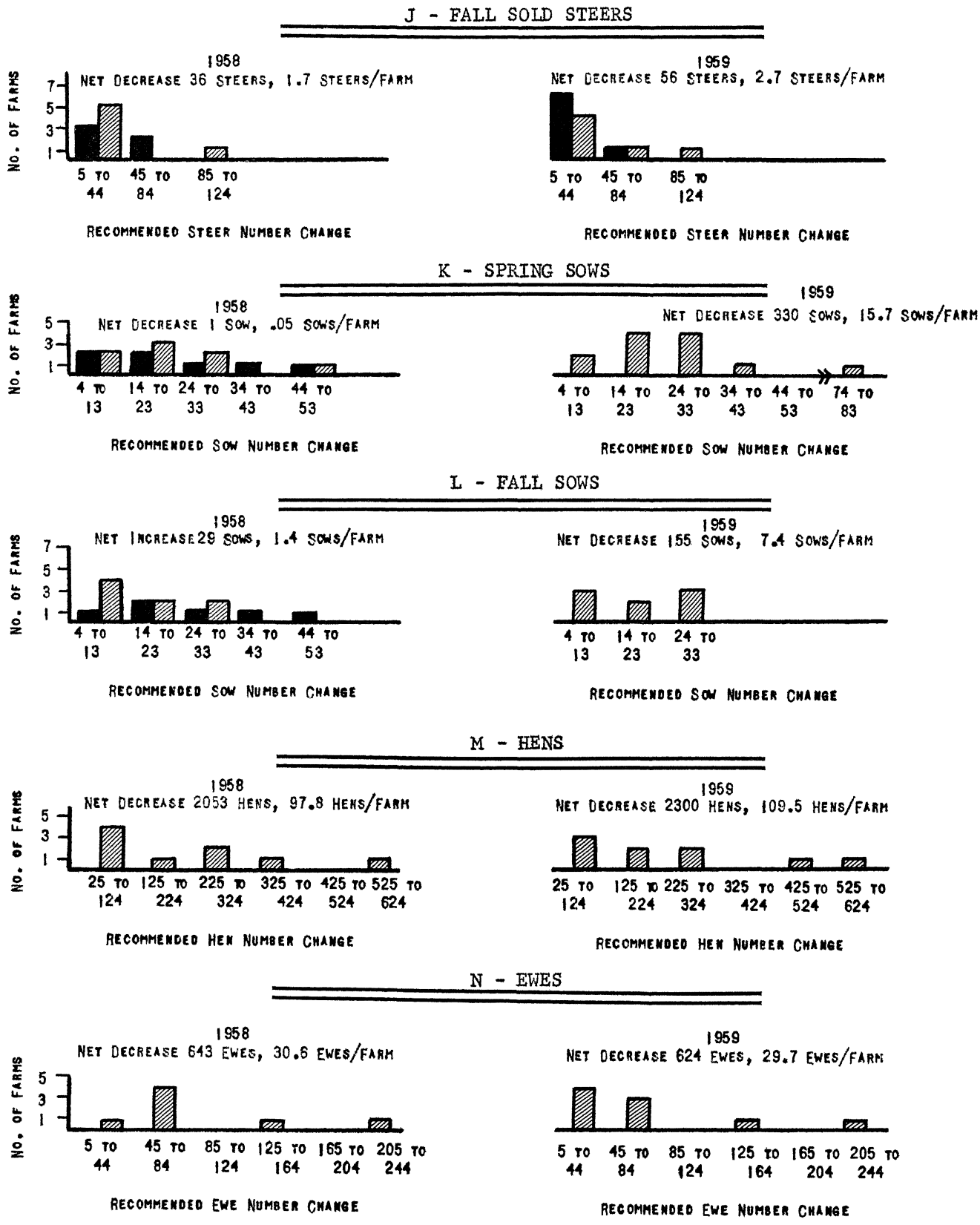

Fig. 6.—Recommended enterprise size changes necessary to conform to programmed optimum size, by number of farms, by years.

Other differences between the actual production plans and the optimal organizations are shown in Figure 6. Generally, the sample farmers had too much rotation pasture for the amounts of livestock necessary to optimize resource use but had too little hay ground.

It is interesting to note the recommended livestock changes during the 1958-59 period. The programmed solutions for 1958 called for dairy and beef cows to decrease, a large increase in feeder steer feeding, a slight increase in fall sow farrowings, and no change in number of spring litters. In 1959, as price relationships changed, the sample farmers should have dropped 113 of their dairy cows and 176 beef cows, reduced spring and fall farrowings by 330 and 155 litters, respectively, and added a net of 3,804 feeder steers to the numbers actually being fed.

These solutions reflect the relatively high fat beef prices in 1958 and 1959 and the drop from $20 to $15 in butcher hog prices from 1958 to 1959. The drop in hog price in 1959 led to the reduction in farrowing shown in the programmed optimums. Milk price was held at $3.95 net for grade A during the 2-year period.

The prevailing prices of hens, eggs, lambs, and wool in 1958-59 were low enough, relatively, so that the programs recommended total decreases of 2,053 and 2,300 hens and 643 and 621 ewes on sample farms.

The recommended adjustments in enterprises result in changes in land, labor, and capital use. However, none of these changes are fully examined in the programming solutions, other than the implications of the unused programming capital and labor. Unused resources are shown separately in the final worksheets (example in Appendix B).

The mean amount of the beginning capital[18] resource was $23,012 for the 21 farms and ranged from $4,465 to $39,053. Two farms had less than $10,000 and ten others were between $10,000 and $25,000. Nine operators had $25,000 or more available capital. Five of the programmed solutions for 1958 required less capital than the operators possessed and the other 16 optimum plans utilized all available capital. Higher incomes above variable costs were achieved on these five farms through proper resource allocations, with about $7,500 per farm less required capital than was available.

In 1959, ten programmed solutions produced higher incomes with $86,000 less total capital needed than was available. The analysis did not include the alternative of providing more capital than the operator controlled. So no conclusions are available on the marginal productivity of additional capital.

[18]All references to capital in this section refer to the amount of capital available as a resource in the linear programming model.

Income Differences Between Actual Organization and Programmed Organization

In the programming process, fixed costs were not included in the model but were subtracted later.[19] Prerequisites also were added subsequently. In the optimum solutions, the value of unpaid family labor had not been taken out. Thus, the income derived from programming is actually a net income above variable costs for the farm family. The income from the actual farm organization was modified to approximate income above variable costs and thus be comparable to the programmed results.

Annual family net income above variable costs per farm averaged $16,802 for the 21 programmed optimum organizations and $7,133 for the 21 actual farm organizations, a difference of $9,669. This was statistically significant at the 0.01 probability level.

The above analysis used different production and cost coefficients in the programming problem than the 21 operators actually used. The programming values were modes of a 3-year farm history for each farm and the production and price coefficients associated with the actual organizations were those occurring each year. To isolate the amount of annual net family income difference due primarily to organizational difference, the net family income above variable costs for each year was computed. The price and production coefficients in the programming problems were used with the actual farm organizations for each year.

The mean annual income for the 21 farms was $10,469 or $3,336 more than the original $7,133. This left $6,333 ($16,802 minus $10,469) as the mean loss of family variable income due to the differences in farm organization. This income difference tested significantly large at the 0.01 probability level when a paired difference group comparison was made.

OBSTACLES TO ADJUSTMENT

During the course of data collection, discussions with cooperators, analysis, and interpretation, several deterrents to adjustment were noted. The following discussion is a combination of subjective observations and evaluations by the authors and objective results of data analysis.

The following factors appear to obstruct adjustments in varying degrees on the sample farms:

Rigidity of resources constitutes an effective barrier to major short term adjustment. High fixed costs

[19]An example of this is shown in Appendix B.

and specialized investments make enterprise changes more costly. Operators appear to take less adjustment action unless they have the reassurance of forward pricing or feel that some permanency is attached to the new price relationships.[20]

Percentage of land in cropland influences the profitability of enterprise changes between different types of livestock and particularly changes involving deletion of livestock enterprises.

External resource rationing tends to force some operators into a safer but often less profitable position.

The cost of adjustments themselves frequently serve as deterrents to adjustment. It was observed in the data that one type of adjustment frequently necessitates other adjustments. Thus, the cost of the total change often stops the initial partial change.

Voluntary capital rationing was reported by many sample farmers as a major cause prohibiting adjustments which the operator himself felt would be profitable.

During the interviews, the authors repeatedly were confronted with reluctance of the operator to make adjustments because of his desire to maintain a fixed *crop rotation.*

Lack of knowledge of alternative resource uses was frequently given by operators as the reason for adhering to given enterprise combinations, even in the face of adverse price and/or cost relationships.

Several operators reported inability to adjust because of *tenure arrangements* (father-son partnerships mainly) in which the capital resources were controlled by a senior, more conservative, partner.

Some operators, because of *emphasis on timeliness*, own major harvesting machines which they cannot justify in light of the small volume of use, availability of custom machines, and degree of risk-loss normal to the area. Some operators have increased use-volume by performing off-farm custom work but others continue to pay excessive per acre harvesting costs through ownership.

A long run pessimistic outlook kept several operators from making adjustments which they admitted should have been made. The 21 sample farmers were asked in the spring of 1960 what they expected prices and costs to be in 1965 relative to 1959. Fifteen operators expected from 5 percent to 30 percent increases in farm costs. Only seven expected higher corn prices, four felt milk prices would increase, and twelve and eight operators, respectively, predicted increases in the prices of hogs and beef. Thus, most operators felt they would be relatively worse off in 1965 than in 1960. It was observed that cost control became more strict on many of the farms in 1958 and 1959 than had been true before that time. Cost level and number of adjustments were significantly associated in the correlation analysis in this study.

[20]Tompkin, J. Robert. 1958. Response of the Farm Production Unit as a Whole to Prices. J. Farm Econ. Vol. XL, No. 5.

APPENDIX

APPENDIX A.—Linear Programming Matrix Showing Resource Use Alternatives and Restrictions, Sample 320-Acre Farm (Shown in Table 15).*

Kind of Resources Available	Unit	Amount	Corn (A)	Oats (A)	1-Cut Hay (A)	2-Cut Hay (A)	Rotation Pasture (A)	Permanent Pasture (A)	Soil Bank (A)	Buy Corn (Bu.)	Sell Corn (Bu.)	Buy Oats (Bu.)	Sell Oats (Bu.)
Corn ground	Acre	86	1										
Meadow ground	Acre	71			1	1	1						
Oats ground	Acre	15		1									
Soil bank	Acre	20							1				
Corn	Bu.		—80							—1	1		
Oats	Bu.			—80								—1	1
Hay	Ton				—2	—3							
June pasture	A U.D.						—32	—26					
July pasture	A.U D.				—14		—24	—7					
Permanent pasture	Acre	60						1					
Capital	Dollar	34,315	23.88	16.92	14.17	18.89	8.00	3.33	3.00	1.22		.72	
Hog capital†	Dollar	275											
April labor	Hour	858	.9	2.	.1	.1	.1		1.				
June labor	Hour	858	.5		3.6	3.6	.1		.5				
October labor	Hour	891	2.4										
Dairy housing	Sq. Ft.	7,896											
Hog housing	Sq. Ft.	0											
Other housing	Sq. Ft.	0											
Hen housing	Sq. Ft.	0											
Spring sow limit	Sow	20											
Fall sow limit	Sow	20											
Pork produced	Cwt.												
Beef produced	Cwt.												
Net Income (C_j)	Dollar	—	—25.07	—17.77	—14.88	—19.83	—8.40	—3.50	49.91	—1.25	1.15	—.74	.64

*Disuse and transfer vectors not shown.

†There was a transfer between capital and hog capital. Beginning hog capital was the capital invested in hog equipment.

Kind of Resources Available	Buy Hay (Ton)	Sell Hay (Ton)	Sheep (Ewe)	Poultry (Hen)	2-Litter Hog System (Sow)	2-Litter‡ Hog System (Sow)	Spring Litter Hog System (Sow)	Spring Litter‡ Hog System (Sow)	Fall Litter Hog System (Sow)	Fall Litter‡ Hog System (Sow)
Corn ground										
Meadow ground										
Oats ground										
Soil bank										
Corn			2.5	.84	208	208	107	107	115	115
Oats			2.0	.28	57	57	32	32	33	33
Hay	—1	1	.4							
June pasture			7		13.8	13.8	13.8	13.8	6.5	6.5
July pasture			7		15	15	15	15	6.5	6.5
Permanent pasture										
Capital	21.00		22.25	6.10						
Hog capital					236.70	272.70	174.50	210.50	185.56	221.56
April labor			2	.3	4.	4	4	4	1.1	1.1
June labor			.3	.3	2.3	2.3	2.3	2.3	.5	.5
October labor			.3	.2	4.15	4.15	1.1	1.1	4.15	4.15
Dairy housing										
Hog housing					66.4	66.4	64	64	66.4	66.4
Other housing			15							
Hen housing				3.5						
Spring sow limit					1		1			
Fall sow limit					1				1	
Pork produced					—27.27	—27.27	—13.41	—13.41	—14.31	—14.31
Beef produced										
Net income (C_j)	—21.63	20.00	16.03	.59	—151.08	—151.08	—85.78	—85.78	—97.39	—97.39

‡This alternative includes the investment needed to expand beyond existing capacity.

APPENDIX A. (Continued)—Linear Programming Matrix Showing Resource Use Alternatives and Restrictions, Sample 320-Acre Farm (Shown in Table 15).*

Kind of Resources Available	Spring Feeder Pig (Pig)	Fall Feeder Pig (Pig)	Spring & Fall Feeder Pig (2 Pigs)	Sell Pork (Cwt.)	Beef Cow-Calf (Cow)	October-May Beef Feeder (Head)	Oct.-Oct. Beef Feeder (Head)	Sell Beef (Cwt.)	Dairy (Cow)
Corn ground									
Meadow ground									
Oats ground									
Soil bank									
Corn	11	12	23		36.5	44	38		35
Oats	4	4	8		3.5	5	4		22
Hay					3.06	.8	.4		4
June pasture	1.3		1.3		50		22		38
July pasture	1.5		1.5		51.9		23		38
Permanent pasture									
Capital					357.43	36.08	36.86		526.50
Hog capital	28.01	29.78	53.76						
April labor					3 4	1.2	.5		9.2
June labor	.5		.5		.7		.4		7.2
October labor		.1	.1		3.9	.8	2.5		8.7
Dairy housing									100
Hog housing	8	8	8						
Other housing					44	20	18		
Hen housing									
Spring sow limit									
Fall sow limit									
Pork produced	—1.52	—1.49	—3.01	1					
Beef produced					—7.57	—4.73	—4.73	1	
Net income (C_j)	—15.28	—17.08	—31.53	Variable price**	—59.76	—27.48	—28.30	Variable price**	276.25

**Hog and beef prices were permitted to vary. Thus, these C_j's will also vary. They represent the market price per hundredweight.

APPENDIX B.—Derivation of Family Labor Earnings from Optimum 1958 Programmed Solution (Shown in Table 15).

Activity	Unit	Optimum Amount	Resources Used and Products Produced*, Bought*, or Sold: Corn (Bu.)	Oats (Bu.)	Wheat (Bu.)	Hay (Ton)	Pork (Cwt.)	Beef (Cwt.)	Crop-land
Corn	Acre	106	8480*						106
Oats	Acre	15		1200*					15
Wheat	Acre	20			540*				20
Two cuttings hay	Acre	71				213*			71
Permanent pasture	Acre	60							
Buy corn	Bu.	9787	9787*						
Buy oats	Bu.	1541		1541*					
Buy hay	Ton	42				42*			
Sell wheat	Bu.	540			540				
Two litter hog system	Sow	20	4160	1140			545*		
Oct.-May beef feeders	Head	316	13904	1580		253		1495*	
Oct.-Oct. beef feeders	Head	5	190	20		2		24*	
Sell beef	Cwt.	1520						1520	
Sell pork	Cwt.	545					545		

*Items produced or bought are marked with an asterisk; those used are not marked.

Activity	Unit	Resources Used and Products Produced*, Bought*, or Sold: Capital ($)	June Past. AUD	July Past. AUD	April Labor (Hour)	June Labor (Hour)	Oct. Labor (Hour)	Hog Hous. (Sq. Ft.)	Other Hous. (Sq. Ft.)	Income: Per Unit ($)	Total ($)
Corn	Acre	2351			95	53	254			—25.07	—2657
Oats	Acre	254			30					—17.77	— 267
Wheat	Acre	395					26			—20.76	— 415
Two cuttings hay	Acre	1341			7	256				—19.83	—1408
Permanent pasture	Acre	1998	1560*	420*						— 3.50	— 210
Buy corn	Bu.	11940								— 1.25	—12234
Buy oats	Bu.	1110								— .74	—1140
Buy hay	Ton	882								—21.63	— 908
Sell wheat	Bu.									2.00	1080
Two litter hog system	Sow	4734	276	300	80	46	83	1328		—151.08	—3022
Oct.-May beef feeders	Head	11401			379		253		6320	—27.48	—8684
Oct.-Oct. beef feeders	Head	184	110	120	2	2	12		90	—28.30	— 142
Sell beef	Cwt.									25.65	38988
Sell pork	Cwt.									20.25	11036
Resources Not Used			1174		265	501	263		158		

*Items produced or bought are marked with an asterisk; Those used are not marked.

Value of House Rental and Garden	2373
Total Farm Earnings	22390
Taxes and Depreciation on Land, Buildings, Machinery	9027
Interest on owned capital in Land, Buildings, Machinery	3654
Family Labor Earnings	9709

APPENDIX C.—Comparison of Area Studied to State Totals of Land Use and Crop and Livestock Production, 1956.*

Item	Unit	State Total	Sample Area	
			Total	Percentage of State Total
Number of counties	Co.	88	9	10.23
Number of farms	No.	162,000†	18,105	11.18
Farmland	Acre	19,400,000†	2,205,000	11.37
Average size of farms	Acre	120.5†	121.8	——
Cropland	Acre	12,570,000†	1,721,000	13.69
Cropland harvested	Acre	10,638,540	1,463,200	13.75
Land in harvested crops				
Corn	Acre	3,523,000	625,000	17.74
Soybeans	Acre	1,301,000	154,900	11.91
Wheat	Acre	1,496,000	203,900	13.63
Oats	Acre	1,101,000	189,300	17.19
All hay	Acre	2,244,000	273,500	12.19
Crop production				
Corn	Bu.	211,380,000	41,553,000	19.66
Soybeans	Bu.	31,224,000	3,857,000	12.35
Wheat	Bu.	38,896,000	5,055,000	13.00
Oats	Bu.	47,343,000	9,019,100	19.05
All hay	Ton	3,860,000	500,000	12.95
Average crop yields				
Corn	Bu.	60.00	66.50	——
Soybeans	Bu.	24.00	24.90	——
Wheat	Bu.	26.00	24.80	——
Oats	Bu.	43.00	47.60	——
All hay	Ton	1.72	1.83	——
Estimated numbers of livestock on farms Jan. 1, 1956				
All cattle and calves	Head	2,393,000	324,400	13.56
Milk cows and heifers	Head	892,000	103,400	11.59
Hogs, including pigs	Head	2,836,000	599,600	21.14
Stock sheep	Head	1,036,000	122,400	11.81
Chickens	Head	14,298,000	1,634,000	11.43

*Unless indicated otherwise, these data are taken from or computed from Ohio Agricultural Statistics 1955 and 1956, by J. E. Pallesen and Eldon Houghton, Agricultural Marketing Service, USDA, and M. G. Smith and G. A. Tejada, Department of Agricultural Economics and Rural Sociology, Ohio Agricultural Experiment Station. Published by Ohio Agricultural Experiment Station.

†Values interpolated from the 1954 and 1959 U. S. Census of Agriculture for Ohio.

The State Is the Campus for Agricultural Research and Development

Ohio's major soil types and climatic conditions are represented at the Research Center's 11 locations. Thus, Center scientists can make field tests under conditions similar to those encountered by Ohio farmers.

Research is conducted by 13 departments on more than 6000 acres at Center headquarters in Wooster, nine branches, and The Ohio State University.

Center Headquarters, Wooster, Wayne County: 1918 acres

Eastern Ohio Resource Development Center, Caldwell, Noble County: 2053 acres

Mahoning County Experiment Farm, Canfield: 275 acres

Muck Crops Branch, Willard, Huron County: 15 acres

North Central Branch, Vickery, Erie County: 335 acres

Northwestern Branch, Hoytville, Wood County: 247 acres

Southeastern Branch, Carpenter, Meigs County: 330 acres

Southern Branch, Ripley, Brown County: 275 acres

Vegetable Crops Branch, Marietta, Washington County: 20 acres

Western Branch, South Charleston, Clark County: 428 acres